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# MECHANICAL ENGINEERING

· APRIL 1948 ·


The Industrial Application of Nuclear Energy — *L. B. Borst* — 295

Major Advances in Plastics During 1947 — *J. W. Underwood* — 298

Design Features of a 4800-Hp Locomotive Gas-Turbine Power Plant — *Alan Howard* — 301

Advances in Rubber During 1947 — *V. A. Cosler and S. W. McCune* — 307

Flow of Coal in Chutes — *E. F. Wolf and H. L. von Hohenleiten* — 313

Engineering the Tin Can — *H. S. VanVleet* — 315

Progress in Railway Mechanical Engineering, 1946-47 — 321

Bankruptcy of "Internationalist" Thinking — *T. E. Baker* — 336

**Departments**

Briefing the Record, 338
ASME Technical Digest, 354
ASME News, 375
Catalog Briefs, *Adv. Pg.* 41

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# MECHANICAL ENGINEERING

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## *Contents for April, 1948*

THE INDUSTRIAL APPLICATION OF NUCLEAR ENERGY . . . . . *L. B. Borst* 295
MAJOR ADVANCES IN PLASTICS DURING 1947 . . . . . *J. W. Underwood* 298
DESIGN FEATURES OF A 4800-HP LOCOMOTIVE GAS-TURBINE POWER PLANT . *Alan Howard* 301
ADVANCES IN RUBBER DURING 1947 . . . . . *V. A. Cosler and S. W. McCune, 3rd* 307
FLOW OF COAL IN CHUTES . . . . . *E. F. Wolf and H. L. von Hohenleiten* 313
ENGINEERING THE TIN CAN . . . . . *H. S. Van Vleet* 315
PROGRESS IN RAILWAY MECHANICAL ENGINEERING, 1946–1947 . . . . . 321
BANKRUPTCY OF "INTERNATIONALIST" THINKING . . . . . *T. E. Baker* 336

EDITORIAL . . . . . 293
BRIEFING THE RECORD . . . . . 338
ASME TECHNICAL DIGEST . . . . 354
COMMENTS ON PAPERS . . . . . 366
REVIEWS OF BOOKS . . . . . 367
ASME BOILER CODE . . . . . 371
ASME NEWS . . . . . 375
ASME JUNIOR FORUM . . . . . 383
CONTENTS OF ASME TRANSACTIONS . . 394

CATALOG BRIEFS . . . . . 41
INDEX TO ADVERTISING PAGES . . . 136

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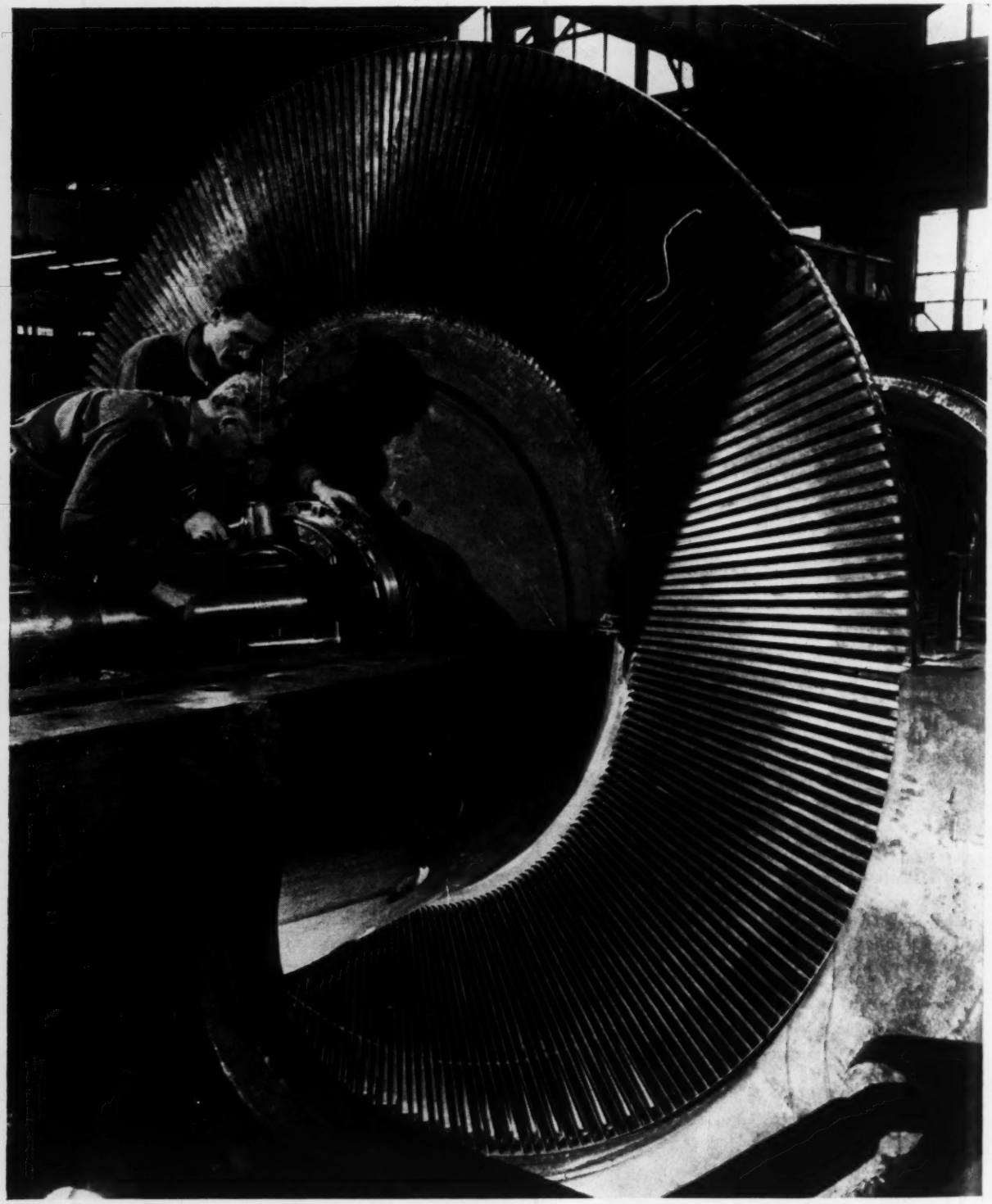

*Rotor for a 60,000-kw Steam Turbine at the Schenectady Works of the General Electric Company*

MECHANICAL ENGINEERING

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APRIL
1948

GEORGE A. STETSON, *Editor*

# *The Task Ahead*

THE immediate task of the engineer is to maintain a high rate of production of goods and services and to extend it throughout the world wherever possible in spite of all obstacles.

Production has always been the function of the engineer; it is his responsibility also. In this country it is upon him that a large measure of the task of preserving high production rates will be placed. This nation has led the world in productive achievements and particularly in low man-hour rates per unit of product. Based upon the hours spent by the worker at his task, the costs of goods and organized services are lower here than anywhere in the world.

High output of production per man-hour was not the result of engineering and technology alone. It depended also on the political and economic conditions which prevailed in America and upon the habits and spirit of the people. American engineers still retain very real and important advantages; but even in this country conditions have been undergoing change during the last generation. The demands on the engineer will be greater in the future than they have been in the past, if high production and high rates of production are to be maintained or increased. It will be necessary to continue to improve all technical phases of production, research, development, design, and operation; but in addition it will be necessary to cope with changes in economic, social, and political conditions. Upon the engineer rests the responsibility for maintaining a highly mechanized society and for carrying on the productive functions that have been so richly rewarding to our people and to our standard of living, because the engineer has the greatest competence to assume it.

Machinery and methods respond to the rational treatment of science and engineering. They adhere strictly to the laws of their natures and these laws are fairly simple and well known. But machinery and methods are useless without men, and men respond to laws that are complex and obscure. When the engineer is forced to take over not only the job of developing, maintaining, and operating the machinery of production but the handling of men as well, he finds that his knowledge of science and engineering must be supplemented with a knowledge of men and organizations. Just as he must devise useful mechanisms and products from the discoveries of science, so also must he devise smoothly operating and effective organizations of men for producing them. Today, at least, this is the larger task because it is the more difficult one. Unless this task is properly performed, high production and high rates of production cannot be maintained.

The original task of production required a familiarity with applied science, materials, forces, machinery, energy, processes, and methods. The knowledge was factual and was based on science or on acquired experience. Mathematics afforded a useful tool for the study and application of this knowledge. Hence the education of the engineer was based on the natural sciences and their application, with a large amount of training in technology. That this education was satisfactory can be judged from the remarkable progress engineering made through the efforts of the generations of engineers who were educated in accordance with that pattern. But as it became evident that a majority of engineers would inevitably enter responsible administrative posts, it was realized that engineering students should be forced to undergo a broader educational experience than had been made available to them in the past.

What has happened to make this change in the education of the engineer desirable and necessary is common knowledge. Engineering has been a dominant factor in civilization for the last hundred years and during our generation the influences it has had on our lives have been growing continuously. In a material sense these influences have been beneficial. We have ample food and other essentials of living, almost limitless creature comforts, cheap and convenient means of transportation and communication, facilities for the enjoyment of the leisure which high productive effort has afforded us, and widespread educational opportunities for the development of the individual. Truly, a visitor from an alien world would expect to find us living in peace and happiness and enjoying an unparalleled sense of security. But, as we all know, he would not so find us. Something has gone wrong. Some element essential to the realization of what we should have in the way of the satisfactions of living has been omitted.

The scientist and the engineer have been caught in a net of their own devising. Theirs has been the rational approach to life. Mathematics is their tool and their language, and with what can be expressed in that precise language they feel comfortable. They are uneasy in areas where this language fails them. For the sake of their scientific reputations they prefer to stay within the familiar galleries of science. For it is disquieting to look outside where there is darkness and confusion instead of the clear light of science and the precise orderliness of natural law.

Yet the scientist and the engineer do look out and what they see disturbs them. They see that certain

forces they have unlocked can be used by vicious and unscrupulous persons in a tragically evil way. They see that the benefits of their discoveries do not necessarily make men better or more noble. At least where their dealings with men are concerned, they discover that a mechanistic and materialistic world is not enough to safeguard human happiness. Perhaps even natural law needs the guidance of moral law.

Not many years ago scientists and engineers were saying that these matters were none of their responsibility. It was up to society to make adjustments to changes in economic and social life. It was up to society to discover and apply the moral law. Today, this disclaimer of responsibility is less frequently heard. Instead, we find scientists and engineers showing genuine concern over the implications of their work and a willingness to do what they can to solve the social, economic, political, and moral problems that face the world. These problems must be solved because if they are not, the scientist will cease to be a free agent and the engineer will find himself working for the enslavement and not the benefit of his fellow men.

If we have come, as seems possible, to a situation in which the technical work of the engineer is threatened because lack of progress and understanding in other areas leads it to frustration, then it becomes important for the engineer to do everything in his power to counteract these disturbing influences. If his technical knowledge is not enough to accomplish this task, he must supplement it with knowledge of another sort, and hence his education must contain elements which will develop him into what Elliott Dunlap Smith has called a man of full habit of mind, or what E. W. Sinnott has termed the whole man.

It is fortunate that engineers themselves are coming to a realization of the need they have for a broader and a deeper understanding of the world in which they live and of the people that inhabit it. They have become conscious of the strategic position in which they are placed in respect to science on the one hand and labor and society in general on the other. They admit that their task is considerably greater than the technical one upon which high production and high production rates are primarily based. They are endeavoring, in their educational systems, to expand their technical competence and usefulness. Greater attention is being given to the fundamental sciences upon which practical developments in goods and methods and machinery are based. Emphasis is placed on research and development, upon design and construction, and upon the operation of machinery in integrated systems of production. But they are also endeavoring to introduce into their educational systems, and particularly into the minds of the young men who are preparing for careers in engineering, formal and informal methods by which these young men may become conscious of the great need which exists in the world today for the development of men of full habit of mind, for the development of the whole man.

In this great area of human knowledge and experience the engineer does not find the firmly established and clearly stated facts which are so abundant in his scientific and technical studies. Here a different approach is necessary.

Although moral law, and the relationships between individuals, and between the state and the individual, cannot be reduced to mathematical formulas, the engineer recognizes that they are no less important and valid. They must be searched out, comprehended, and brought under direction and control, if society is to continue its forward advance of material progress based on the discoveries of science and made effective by the engineer's genius for high productive effort.

The engineer today faces the opportunity and finds himself under the responsibility of bringing into the productive process that nontechnical element of moral purpose and direction which will provide flesh and spirit to the dry bones of industrial organization. In equipping himself to do a better job in the technical phases of his work he must also equip himself for leadership in society and for service to it, unless he is content to see his technical efforts end in the frustration of war and disorganized, futile, and degenerating social systems. To save what he himself has created, he must give immediate and powerful aid to the design and operation of social, economic, and political mechanisms. Without these mechanisms, the engineer's work will be lost. In his strategic position, the engineer can, if he will train himself to do so, become the leader of a great movement to develop high production for the benefit of his fellow men and to make it possible for the technical phases of his work to go forward without creating social, economic, and political disturbance. If he can develop as a man of full habit of mind, no one can do this task better than the engineer, and if he does it, the blessings of high production will accrue to all men.

Faced with the double task of converting the discoveries of science into products and processes for the benefit of mankind and of guiding organizations of men to perform the work of the world and to increase their productivity, the engineer must give thought to the requirements of his education and training. No halfway measures will do for the man who is to be fully professional in character. He must develop the whole man. He cannot neglect the sciences and their application, but neither can he neglect those other studies which give him an understanding of his fellow men and the world in which he and they live. His language must be more than the language of mathematics, for he must have terms in which to express and find access to the imponderable values of human experience in all its richness and frailty. He obligates himself to a career of extraordinary service.

He chooses to travel what Wickenden has called the Second Mile—"the mile of voluntary striving which leads to deeper experiences and higher rewards. . . Where men seek excellence rather than quantity, labor for self-expression rather than material gain, and give that unrequited margin of service to the common good which alone invests work with wide and enduring significance."

Substance of an address to the graduating class, Stevens Institute of Technology, Hoboken, N. J., Jan. 31, 1948.

# *The* INDUSTRIAL APPLICATION *of* NUCLEAR ENERGY

By LYLE B. BORST

CHAIRMAN, NUCLEAR REACTOR PROJECT, BROOKHAVEN NATIONAL LABORATORY, UPTON, L. I., N. Y

THE industrial applications of atomic energy will be legion—but will certainly not be immediate.

This joint statement of faith and reservation is the common feeling of most of the people directly associated with atomic-energy development. We have faith that the year 1942—the year of the first chain reaction—marks the beginning of the atomic age, an age which will be characterized by further triumph of man over his environment—his physical and biological environment and, perhaps, even his social environment. Profound changes will come, but they are not "just around the corner," for we face new problems requiring time, ideas, man power, and money to solve.

Some of the problems involved, for instance, in the development of an atomic-powered automobile do not differ individually from those arising in many industries. I do believe that the number of obstacles between our present state of knowledge and your atomic-powered Ford exceeds, both in variety and complexity, the problems facing the inventors of the internal-combustion engine. In fact, it is doubtful whether the difficulties can ever be overcome in this particular application, for we just don't know how to build a safe engine weighing less than about 20 tons.

Before predicting the future, however, let us take stock of the present. The development of atomic energy up to the present has cost about two and a half billion dollars—not an inconsiderable sum even as industries go. Most of this money has been expended through industrial contracts. At the present time General Electric Company, Carbide and Carbon Chemicals Corporation, Monsanto Chemical Company, The Kellex Corporation, Standard Oil Development Company of New Jersey, and 200 to 300 other industrial concerns hold contracts with the Atomic Energy Commission. The variety of products produced varies from Geiger counters, electronic circuits and tubes, special steels and nonferrous alloys, graphite, and lubricants to U235, Pu239, and an assortment of one-hundred-odd isotopes, both radioactive and stable. At the present time we have a far-flung established and going industry.

This is a government-controlled industry, to achieve the policy established by act of Congress: ". . . . . it is hereby declared to be the policy of the people of the United States that, subject at all times to the paramount objectives of assuring the common defense and security, the development and utilization of atomic energy shall, so far as practicable, be directed toward improving the public welfare, increasing the standard of living, strengthening free competition in private enterprise, and promoting world peace." This industry has the advantage and perhaps a few of the disadvantages of government control.

This industry must always be faced with the difficult distinction between "dangerous" activities, i.e., those leading to the bomb, and beneficial uses. I am sure that most of us will agree that under the present international circumstances information associated with the bomb is not appropriate material for public discussion. I am sure we would also agree that information not associated with military applications must necessarily be freely discussed. You who have so graciously contributed the two and a half billion dollars have every right to know what you are getting for your money. It is important that you know what we are doing and that you approve of our plans. We regret that in many cases we cannot discuss completely and candidly all the aspects of all the interesting problems in which we are engaged. There is nothing I would enjoy more than to discuss the work in which I am engaged, the design and construction of the Brookhaven Nuclear Reactor. The problems we have encountered in building this peacetime unit are just those met in building a plutonium production pile. It is an unfortunate fact of nature that the dividing line between beneficial and military application is neither straight nor clear. I hope you will pardon me if my discussion of the future atomic-power industry seems incomplete.

Contributed by the Nuclear Energy Application Committee and presented at the Spring Meeting, New Orleans, La., March 1–4, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

### ATOMIC POWER PLANTS

The development of atomic power is one of the most direct and foreseeable future industries. It has been common knowledge that atomic nuclei were potential sources of energy, and it was established before the discovery of fission, that the source of the energy of the sun was such a nuclear source.

In 1948, less than ten years since the discovery of fission, we have installations making heat at the rate of many thousands of kilowatts. Unfortunately, the heat is generated at such a low temperature that efficient generation of electricity is not possible. How many more years will elapse before we can generate electric power from this heat? We hope to demonstrate power generation at Brookhaven within the next two years. Our reactor is designed for research and not as a power plant, so that our power will definitely be a by-product. The capacity of this system will not be sufficient to operate the reactor at its full level, but will probably permit operation at a reduced level. However, this initial demonstration will not inaugurate the era of atomic power by any means. It will be another 10 to 20 years before atomic energy can compete favorably with coal as a source of industrial power. Let us remember that it has taken more than a century to make the energy conversion from coal 25 per cent efficient.

We have looked long and hard for a trick method of getting electric energy directly from the chain reaction. We would greatly enjoy building a chain reactor with two wires leading out to carry away the energy at a modest voltage of a million or so volts. There ought to be a way of using this energy directly. We can get some electricity from a reactor directly—in fact, we normally control it by this means. We can even dream up a system by which we can achieve a reasonable efficiency. The only trouble is that such a system will not support a chain reaction.

So far we have learned no "open sesame." We acknowledge generally that electric power, for the foreseeable future, will be generated by means of the conventional heat engine. Such an engine must necessarily work from a high-temperature source.

Here is one present difficulty. Using available materials satisfactory from a nuclear point of view, it has not been possible to operate reactors at appropriate temperatures. It is one of the ironies of nature that common engineering materials, such as ferrous metals and most nonferrous metals, absorb neutrons and may not be used inside thermal neutron reactors. Those which do not absorb neutrons lack mechanical strength and undergo excessive corrosion at the necessary temperatures. The few exceptional materials having all of these qualities are excessively expensive.

Studies directed toward overcoming these difficulties are now under way and progress is to be expected within a few years!

The consumption of uranium fuel in a reactor necessarily produces a variety of ash—called fission products. These products consist of several dozen elements having about half the atomic weight of uranium. Many of these substances have deleterious effects because they absorb the neutrons required to maintain the chain reaction. Their production also modifies the crystalline structure of the solids within which they are generated.

I might illustrate this by what might be called the alchemists' nightmare. Alchemists spent a lot of time trying to transmute low elements into gold, and a fraction of this time was spent on the transmutation of mercury. We can now do this and we can even undo the alchemists' dream by converting gold into mercury. In fact, there are scientists—strange people—who want the mercury more than the gold.

If we place a piece of gold in the reactor it will absorb neutrons and slowly be converted into mercury. Just when does it lose the characteristics of gold and achieve the characteristics of mercury? Likewise, uranium would slowly be converted to fission products having completely different properties.

It is apparent therefore that the nuclear fuel must be reprocessed at intervals to remove the ash. By present techniques this involves elaborate chemical and metallurgical processing which must be conducted behind thick concrete walls entirely by remote control.

Other problems confronting us have to do primarily with fissionable material economy. I have here a sample of uranium metal. When freshly prepared it does not look different from steel. This piece has a layer of black oxide in it. As you know, only one atom in every 140 atoms is the isotope U235 which undergoes thermal neutron fission. The other 139 are all U238 which absorbs neutrons to make plutonium.

At the present time the principal reactors throughout the country are based on the fission of U235. Our utilization of uranium is therefore less than one per cent efficient; while thorium, the other potentially useful element, is not used at all. Even though uranium is as abundant in the earth's crust as lead, high-grade deposits are scarce.

To make a large-scale power industry possible, we must learn to use U238 as well as thorium. When this is possible we shall have enough raw materials to operate the nation's power plants for many centuries to come. Once again, experiments, now under way, will tell us in a few years whether this is possible.

The efficiency of a power plant will be judged to a large extent by the power-generation rate for a given inventory of nuclear fuel. Since the fuels are very costly and scarce, the economic feasibility of competitive atomic power will be determined by the efficiency of the power-plant design.

Even under the most optimistic circumstances it is going to be exceedingly difficult to compete on a straight cost basis with coal as a source of power. At Brookhaven National Laboratory, where we are constructing a reactor for peacetime research, we will *use* a lot of power. The incremental power cost on Long Island is 0.6 cents per kwhr. Under these circumstances, I am quite confident that our nuclear reactor will not put the Long Island Lighting Company out of business.

This reactor is designed as a research tool for producing neutrons and has little similarity to the future power plant. If, however, it were possible to sell generated power at 10 cents per kwhr, we *could* generate enough power to pay for the whole installation in about ten years.

Under these circumstances, because of the excellent coal resources in the United States, it is quite possible that atomic power will become economically sound in other countries before it can compete with other sources here. We know that England is directing her development toward power to relieve her coal shortage. They already have a reactor in operation from which they expect to extract power on an experimental basis.

The industrial rehabilitation of France will depend in large measure on her ability to build up a power industry. At the present time a large fraction of the coal consumed is imported at a cost of $20 per ton. Atomic power has greater urgency for these nations than it has for us.

### ATOMIC-POWERED SHIPS AND AIRPLANES

The unique characteristics of atomic power plants will undoubtedly permit them to compete with other power sources under special conditions. As a mobile power source it is unique, for it will be the first engine which is not dependent upon the earth's atmosphere. Both the steam engine and the internal-combustion engine depend upon the oxidation of a fuel by air. Fission, being a nuclear reaction, is not dependent upon such chemical reactions. The application of this power source to the submarine is obvious.

The small weight of fuel required will mean atomic-powered ships and, perhaps, even airplanes which will refuel only at rare intervals.

The low cost of fuel transportation permits the use of atomic power plants to advantage in inaccessible places having no local power sources. It should be possible to irrigate and place under cultivation desert areas which are now useless.

### USEFUL INDUSTRIAL APPLICATIONS

Other industrial applications of reactors may avoid the generation of electric power. Reactors are admirable heat sources and, as such, may some-day be used in industries like the metallurgical industries which require very high temperatures.

The fission products earlier compared to ash are an abundant source of useful radioactive elements. In quantity they exceed by hundreds and thousands of times the radium used in commerce. At the present time radium is used for therapy, for industrial radiography, and for the preparation of luminous paint. We even have radioactive spark plugs. It is at least possible that radium will be replaced eventually to some extent by one or another variety of artificially prepared material. Radiocobalt, for instance, makes a very acceptable substitute for radium for therapy and radiography.

It is not easy to see exactly where radioisotopes will be useful in the consumers' market. The uses of greatest importance are likely to come in connection with the production and particularly the development of marketable goods.

The logging of oil wells by neutrons as well as gamma-ray sources is an established technique. I understand that an instrument is in use at present in the petroleum industry which measures (by means of gamma rays) the wall thickness of a steel pipe or plate without using calipers or drilling holes.

Instruments for the control of liquid densities, liquid levels, the homogeneity of mixtures, and the thickness of production items may all be developed with a little ingenuity from our present stock of knowledge.

At some time in the future it may be possible to maintain process control by means of appropriate radioisotopes. As an example, in the steel industry the addition of a small quantity of short-lived radio silicon to the charge entering an open-hearth furnace would permit minute-by-minute control of the silicon content of the steel. Analysis for silicon would then be done by means of a Geiger counter without the time-consuming process of chemical analysis.

A word of caution must be injected here, for industries using such methods must insure the purity of their product. For this reason the radioisotopes used should be short-lived—disintegrating into stable, nonradioactive elements before the product leaves the processors' hands.

The examples just mentioned illustrate the uses of these new radioactive materials in existing industries.

The development of radical improvements in present industries and completely new industries will inevitably follow the use of radioisotopes in research. This statement may be made with certainty even though it is impossible to specify what these developments and industries will be. Radical changes in technology have always followed fundamental scientific discoveries. The radio industry proceeded from the early studies of Marconi, deForest, and Armstrong. The automotive and aviation industries followed the development of the internal-combustion engine.

As an example, again in the steel industry, radio sulphur and radio iron are being used to study the interchange of sulphur between molten metal and slag. It appears likely that information thus obtained may improve one of our most basic industries.

One of the earliest uses of radioisotopes was to trace the use of phosphorus by a growing plant. Radio phosphorus was incorporated into a commercial fertilizer and was used in this form to fertilize experimental plants. The way in which phosphorus was absorbed and distributed in the plant was followed by means of the radioactivity. Information obtained by this technique is valuable in determining the most economical and efficient use of fertilizer.

Carbon 14 might perhaps be called the queen of the radioisotopes. The range of problems which may be studied by its means is limitless. One example is the study of the Fischer-Tropsch process for making gasoline from coal. In almost every case an understanding of the mechanism of the reaction leads to better production methods.

Carbon 14 is in use at the present time at several universities to study carbohydrate, fat, and protein metabolisms. From these and other studies we may achieve a whole new concept of the living process.

Photosynthesis has often been called the most important chemical reaction in the world. It is the process by which every green living plant, using the magic substance chlorophyll, makes sugars, starches, and cellulose from carbon dioxide from the air, water from the ground, and sunshine.

Many scientists have spent untold hours trying to fathom its complexity. By this time there is a rather general understanding of the number and sequence of the various steps in the process. It is to be hoped that with the aid of radio carbon the remaining puzzles will be solved. With such knowledge, it may sometime be possible to manufacture food on an industrial basis, from water and limestone.

Friction is both the friend and enemy of the mechanical engineer. He uses it in brakes, he avoids it in bearings. But does he understand it? The study of bearings is most often made by time-consuming service tests. I do not intend to belittle service tests. Our experience on the project with rotating machinery has caused us to be extremely conservative in bearing design. The development of new types of bearings and the testing of bearing materials is extremely slow by conventional techniques. It has not been possible to measure the loss of bearing material to the lubricant until there is a measureable turbidity. By using radioactive bearings it is now possible to measure the transfer of as little as a millionth of a millionth of a gram of bearing surface either to the other bearing surface, or to the lubricant. Fundamental studies of the phenomenon of friction are being carried out at the present time.

### ATOMIC-ENERGY BY-PRODUCTS

In atomic energy, as in other industries, there are by-products having only an incidental relation to the main work. One of these has been the new materials called fluorocarbons. They cover a complete range from volatile refrigerants and lubricants of all viscosities, to plastics. They are amazing materials. They have new and unusual properties and should find applications in many fields.

The welding of aluminum by means of an argon arc, first developed on the Manhattan Project, is now in use for the production of seam welds of many varieties including drums for shipping special materials.

I have avoided more than passing reference to the bomb in order to show you that there is much more to atomic energy than the development of new and more devastating weapons.

The bomb is always with us, however, and we can rarely discuss a subject completely without infringing on the territory posted "Secret."

You who are technically trained, and who understand the fundamentals of nuclear fission for war and peace, realize that bottling up the whole enterprise behind a solid wall of secrecy, far from fostering, may well jeopardize the nation's security. The bomb and the reactor are products of scientific cross fertilization during the 1930's. Unless we have scientific and industrial intercommunication now we will find ourselves, years hence, in a static position—without the industrial background and development that may be our strength in the future.

Widespread industrial co-operation under the Atomic Energy Act is somewhat difficult. Before revealing classified information we are required to obtain security clearance on the individual concerned. He of course must handle the information he receives in accordance with the established security regulations.

The Atomic Energy Commission is determined to encourage industrial participation. To this end a board of industrial advisers is at present studying methods for this purpose.

Until this industrial board has made its recommendations, it is not possible to state specifically the nature of the arrangement most appropriate to a given individual or industry. In 1946 the Commission instituted a one-year course on reactor problems for engineers at Clinton Laboratories in Oak Ridge, Tenn. Between 50 and 100 engineers attended, receiving theoretical and applied training from the best authorities in the country.

Brookhaven National Laboratory considers industrial co-operation as one of its functions. Since the Laboratory facilities are still in process of construction, no definitive arrangements have yet been made. Brookhaven will implement to the fullest degree policies announced by the Atomic Energy Commission.

The development of atomic energy since the war has taken a new direction, focusing attention upon beneficial peacetime application. It has reached a point at which a widespread industrial technology is possible and is required if the nation is to maintain its pre-eminent position and is to benefit to the fullest extent from the new developments of a new field in a new world.

# *Major* ADVANCES *in* PLASTICS *During* 1947

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PROBABLY the most startling announcement during 1947 was that plastics were being used as drugs (1).[1] It has long been known that excess acidity in the stomach was a direct cause of stomach ulcers. Since ion-exchange resins have been known for many years, it is perhaps only the commendable caution of physicians in not publishing results of medical research until thoroughly checked that has kept this announcement from publication until lately.

An interesting part of this announcement is that the hydrochloric acid adsorbed by the resin in the stomach is released in the intestines to be returned to the body system.

Another announcement that revealed an unusual property of plastics was that, when an electrical potential is applied to transparent plastics, the strains created prior to dielectric breakdown can be viewed by polarized light in the same way as is possible to view strains created by mechanical forces (2). Since mechanical strains will also be visible, it is necessary to view the specimen at zero voltage in order to determine which parts of the strain pattern are caused by the electrical stresses. Because both the strain patterns are visible, the fact has already been established that mechanical stress influences the direction of dielectric breakdown. With this new tool available, it should be possible to gain a better understanding of the cause and mechanism of dielectric breakdown.

### APPLICATION OF POWDER-METALLURGY TECHNIQUES

Mold cavities are much more economical to make by hobbing than machining if a number of cavities are to be made. However, due to the limited amount of upward flow of metal into the engraved portion of the hob it is impossible to hob intricate designs, but these are now practical by powder-metallurgy techniques (3). The hob, mounted on a shank of correct diameter, is inserted face upward in a bull ring of the desired inside diameter. The metal powders are poured on top of the hob and the punch positioned. After pressing at pressures ranging from 30 to 90 tons per sq in., the metal compact is removed and sintered at 1260 C for 1 hr per in. of thickness. Since sintering causes the compact to shrink, the sintered compact, after cooling, is coined, using the original hob to resize the cavity and to give it the same finish as the hob.

Powder-metallurgy techniques are also being used to mold polytetrafluoroethylene (4). Due to the fact that the temperature at which this material can be molded practically corresponds to the decomposition temperature, it has been impossible to mold it. By this new technique, finely powdered polytetrafluoroethylene is pressed into a compact in the same way as is used for making powdered-metal compacts. Pressures of 100 to 3000 psi are usual but may be as low as 25 and as high as 50,000 psi or more. After removal from the mold, the compact is heated to a temperature between 327 C and 400 C for a time sufficient for the entire mass to reach 327 C, the temperature above which the polymer is transparent and below which it is opaque due to a change in crystallinity. Quenching of the heated parts produces tough, resilient pieces, while slow cooling produces parts which are softer and less stiff than quenched parts and have lower tensile strength. Slow cooling is necessary for intricate parts which are likely to distort. Although the parts shrink when sintered, the amount of shrinkage can be predicted and allowed for in making the compact.

### POLYVINYL-CHLORIDE PASTES

During the war, due to a shortage of solvents in England, polyvinyl-chloride pastes were developed which contain no solvent (5). These pastes are based upon the fact that, although the plasticizers used are compatible with the polyvinyl chloride, they are not absorbed by the resin at an appreciable rate at room temperature but are rapidly absorbed at elevated temperatures to form smooth coherent gels identical with regularly processed plasticized polyvinyl chloride. As regularly compounded, the pastes are mixtures of plasticizer, stabilizer, pigment, and resin. They are free-flowing fluids of varying viscosity depending upon the amount of plasticizer. They may be formed into useful articles by spreading with a conventional doctor knife, spraying, dipping, or casting. After application the paste is heated to 140 to 150 C to form a coherent mass (5, 6, 7, 8, 9).

Since no solvents are used in the pastes, thicker coats can be applied by dipping in one operation than could be applied by the older solvent compositions which were limited to dilute solutions because of the limited solubility of the resin and the tendencies of concentrated solutions to gel at room temperature (6, 8). Although cold-dipping forms can be used, the thickness of the coating will be limited by the viscosity of the paste. After gelling with heat, the form can be redipped and the process repeated as many times as necessary to give the desired thickness. However, the more economical way to form thick coats is to heat the dipping form to a predetermined temperature and then immerse it in the paste. The heat of the form partially gels the resin allowing much thicker coats to be built up in a single dipping operation. The resin is completely gelled by further heating and then stripped from the mold (5, 6).

Slush-casting of hollow articles can be accomplished by the same technique, except in this case the paste is poured into the heated mold, taking care not to entrap air bubbles, and then pouring out the excess paste after the desired thickness has gelled onto the walls of the mold (5).

Since very little pressure is required to inject the paste into molds, very light and inexpensive molds of plaster of Paris, brass, or steel can be used, and even a grease gun may be used to inject the paste into the mold (5).

The development of these pastes has made it possible to produce films as thin as 1 to 4 mils with a tolerance of $^1/_{10}$ mil in a relatively simple operation. The paste is knife-coated onto an endless stainless-steel belt, after which it travels through an oven to fuse the resin. After coming from the oven, the film is

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Rubber and Plastics Division and presented at the Annual Meeting, Atlantic City, N. J., December 1–5, 1947, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

stripped from the belt (6). The ability to control the thickness of vinyl films within close tolerances is becoming increasingly important since heat-sealing with electronic heaters is only successful with uniform gage sheets. Experience has shown that, with decreasing sheet thickness, the specific power in watts per square inch required to obtain successful welds increases very rapidly. For example, two sheets each 5 mils in thickness require about 425 watts per sq in., while two sheets each 1 mil in thickness require about 1600 watts per sq in. to form satisfactory welds (6, 10).

### COMPOUNDING MOLDING MATERIALS

A process of compounding the thermoplastic molding materials utilizes a principle quite similar to that for vinyl pastes. The resin, dye, pigment, stabilizers, fillers, and so forth, are placed in a rotatable cylindrical chamber so constructed that while it is rotating the plasticizer and other liquid additives (presumably solvents to hasten the absorption of the plasticizer by the resin) can be sprayed into the chamber as a fine mist. After the proper length of time, hot air is filtered through the material to evaporate the volatile matter. The material is discharged as a free-flowing powder ready for molding (11).

A method of continuous compounding of thermosetting molding compounds was revealed in an article reporting on German practices (12). At first a method was tried similar to extrusion. However, since heat is liberated both because of friction and the exothermic reaction of the resin as it is processed, hot spots were created that caused localized curing of the resin which stuck to the side walls of the extruder, soon causing the entire mass to clog the extruder. The method finally evolved was to feed a premix of the powdered resin, dyes, pigments, fillers, lubricants, and accelerators to the center of a regular set of compounding rolls. Strips of processed resin are cut from the edges of the roll causing the resin to feed out automatically from the center to the sides. Length of time on the rolls therefore was governed by the width of material cut off from both ends. In so far as is known, no similar practice is being used in the United States.

### FORMING THERMOPLASTIC SHEET STOCKS

Thermoplastic sheet stock can be formed either by free blowing or by the use of forming dies. Free-blowing allows only limited control of contours and is adapted only to those shapes more or less hemispherical in structure. However, since nothing but air comes in contact with the surface of the sheet, the optical properties of the original sheet are maintained. For complicated shapes and those having sharp changes in contour, it has been necessary to use forming dies. However, since any imperfection in the surface of the mold is reproduced in the surface of the formed sheet, it has always been necessary to have highly polished molds which were expensive to make. In order to combine the two methods, a new process known as "ridge-forming" has been developed to make shapes which are impossible to form by free-blowing (13, 14).

The heated sheet to be formed is clamped across an opening just a little larger than the horizontal cross-sectional area of the part. The sheet is formed by a skeleton framework which contacts the sheet only at those areas which determine the final shape of the article. If the draw is more than one half the width of the opening, it is desirable to use vacuum-forming first to draw the plastic to a free-blown shape slightly deeper than the depth of the shape desired. The ridge mold is inserted, and the vacuum released, allowing the sheet to snap back and cool in place.

### METHODS OF PREHEATING THERMOSETTING MATERIALS

Preheating of thermosetting materials by use of high-frequency heaters has proved to be economical as demonstrated by its wide adoption by the molding industry. However, the high cost of the equipment, both to install and to operate, has tended to limit somewhat its universal adoption. Steam preheating has overcome this difficulty since steam preheaters are very inexpensive in contrast to dielectric preheaters where preheating of charges of several pounds is desired. Steam preheaters can be combined with infrared as well as electric heaters.

Articles in both American and British magazines (15, 16, 17) indicate that steam preheating was developed independently in both countries. Results indicate that the properties of molded parts made from steam-preheated preforms are about equivalent to parts made from dielectric preheated preforms in all but electrical properties, which rules out steam preheating for high-grade electrical parts.

Preheating time for steam preheating is much longer than for dielectric preheating. In a comparable test where the closing time of the press was 5 sec in both cases, it took 15 sec to preheat with a high-frequency preheater, and 8 min to preheat with a combination steam-infrared preheater. This latter disadvantage can be overcome by using a multiple-tray unit large enough to allow the necessary time in the preheater. One major advantage of steam preheating is that leaving the preform in the preheater for a longer time than is necessary to preheat the preform apparently does not cure the molding compound. In one test run, a set of preforms was heated in a steam preheater for $7\frac{1}{2}$ min. A single preform was removed and transfer-molded and then another preform removed and transfer-molded. The process was repeated until the last preform to be tested was removed after a total preheat time of $48\frac{1}{2}$ min. No noticeable difference in transfer time could be attributed to curing of the preform. Unfortunately, no mechanical or electrical tests were run on the test samples.

Both methods will no doubt be used side by side in many molding plants because of the differences mentioned. Certainly steam preheating would not adapt itself to the combination molding machine announced early in 1947 (18, 19). In this machine, granular molding compound flows by gravity from a hopper to an adjustable metering chamber from whence it is transferred by a hydraulic ram, and then by gravity to a preform chamber where a second hydraulic ram preforms the powder. At the proper time the preform falls by gravity between two electrodes of a high-frequency preheater and again by gravity to the transfer chamber where a third hydraulic ram transfers the compound to the mold cavity. After the compound is cured, the mold opens and the operator removes the flash, runners, and molded parts, as well as any cured compound on the force. After the operator closes the safety gate, the mold closes and locks and another preheated preform is dropped into the transfer chamber for a repetition of the cycle. As can be seen, the cycle involving metering, preforming, and preheating overlaps the cycle transferring and curing the compound.

On a typical job, a kitchen-cabinet handle is molded in an 8-cavity mold, using a 24-sec preheat time and a 48-sec cure time, with an output of 60 cycles per hr.

Electronic preheating is also used in combination with a machine developed to edge-glue lumber, using urea-resin glues (20). Phenolic-resin glues cannot be used at present owing to a tendency to arc during curing. By use of this machine, 1000 ft of lumber with a maximum width of glued panel of 37 in. can be edge-glued in 1 hr. It removes effectively what constitutes the usual bottleneck in the woodworking industry.

Another automatic machine which has increased production greatly and will result in lower costs for transparent boxes is one that will produce 1000 boxes per hr (21). Size limits are infinitely variable from a lower limit of $2\frac{1}{4}$ in. to a maximum

of 13 1/4 in. on either side and a minimum depth of 1/2 in. to a maximum of 4 in. Thickness of stock may be from 5 mils to 20 mils. The machine takes the rolled sheet stock slit to the desired width and automatically blanks, crimps, and glues the stock into a finished box-half. The only concession to ordinary rolled sheet stock that had to be made was that the stock had to be rolled on a core of at least 9 in. diam because, on smaller cores, the material on the inside of the roll had a permanent set with too much curvature to be formed into a satisfactory box.

### ONE NEW MATERIAL ADDED TO TRADE

Although several companies announced new modifications of old materials, such as Plexiglas Special UVA, a polymethyl methacrylate able to adsorb ultraviolet light (22), Plexiglas V, a polymethyl methacrylate having a heat-distortion temperature of 90 C (23), Lustrex, a polystyrene having a heat-distortion temperature of 87 C to 88 C (24), and Tenite III, a cellulose-acetate propionate (25, 26), only one entirely new material was offered to the trade. This new material was diallyl-phenyl phosphonate (27).

As with all monomers containing two allyl groups in the molecule, it polymerizes to form a thermoset resin and is capable of conferring this property on copolymers containing it in sufficient quantity. Other properties of the polymer of diallyl-phenyl phosphonate which make it appear promising are its high index of refraction, its ability to wet glass fibers, and its flame resistance. The index of refraction is 1.57 so that as a transparent solid it is exceeded only by the flint glasses and polystyrene. A composition having any desired index of refraction below this value can be obtained by copolymerizing this material with the correct percentage of another polymerizable monomer whose polymer has a lower index of refraction than that desired. Glass-cloth laminates have been made where the glass fibers were wet sufficiently and the index of refraction of the polymer so nearly matched the index of refraction of the glass fibers that the resulting laminates were transparent.

### SILICONE RESINS USED FOR PAPER SIZING

Silicone resins have been found to be excellent for sizing paper (28). Less than 0.1 per cent resin is necessary to give good results. It is added to the beater stock which must have a pH value below 7. Hard water lessens the sizing effect, but this can be overcome by the addition of a small amount of silicone oil emulsion. This small amount of size does not affect the strength properties. Using larger amounts of silicone resin for size lowers the strength properties, except tear strength which is increased. The small amounts of silicone resin necessary for good sizing make the silicones especially suited for papers where the larger amounts of ordinary size might cause difficulties. This suggests the use of silicone resin as a sizing for cigarette and condenser paper.

In retrospect, we can see that the major advances in plastics during 1947 have been distributed between uses, properties, processes, products, equipment, and materials. Advances in such a wide diversity of fields is a sign of a healthy industry.

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*(Continued on page 312)*

# *Design Features of a* 4800-HP LOCOMOTIVE GAS-TURBINE POWER PLANT

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## GENERAL

BEFORE the war, the author's company had actively undertaken the development of gas turbines for such applications as locomotives, ships, small industrial plants, or central stations. Some of these designs have been presented previously by J. K. Salisbury.[2]

During the war, several aircraft gas turbines were developed by the company. Two of these were of the axial-flow type and were of entirely original designs, Figs. 1 and 2.

The company's first postwar design is a plant for locomotive and other applications. The present paper describes the design features of this plant while future papers will present the results of testing and will give the performance based upon these tests.

As will be seen from a study of Figs. 3, 3(*a*), and 4, the general design, which is similar to the TG-180 type, Fig. 2, features a straight-through in-line arrangement of compressor, combustion chambers, and turbine. This design results in a maximum of simplicity and a minimum of pressure losses. This simple design was decided upon both on the basis of a study of the economics of the railway application and because simplicity is inherently desirable. Simplicity, it was felt, was of special importance in our first power plant designed for relatively long life and for heavy fuels, compared with aircraft practice. On the economic side, when space, weight, and cost of apparatus, as well as cost of fuel were considered, it seemed quite conclusive that neither a regenerator nor other elaborations of the cycle were justified.

The plant is rated 4800 shp for the locomotive application when running at 6700 rpm with 1400 F turbine-inlet temperature. The design altitude is 1500 ft with 80 F ambient air temperature.

The over-all thermal efficiency at the turbine shaft is expected to be somewhat over 17 per cent after allowance for all losses and for power for plant auxiliaries. This efficiency is based upon the lower heating value of the bunker C fuel.

The 15-stage axial-flow compressor pumps approximately 70,000 cfm through a pressure ratio of about 6 to 1. As will be seen from the cross section, Fig. 3, the rotor consists of separate wheels bolted together.

There are six all-metal combustion chambers, in which the bunker C fuel is burned. The two-stage turbine discharges to the atmosphere through the diffusing exhaust hood. Ribs between the aft bearing and the turbine casing pass through hollow streamlined struts in the exhaust hood, which shield them from the hot gases. The small fan on the turbine shaft draws cooling air over the turbine stator and down through the hollow struts, as will be further described. The power plant forms an integral unit and no base is required for it.

As installed in a locomotive, it would drive direct-current generators through a reduction gear. Such generators and gearing are being used for the power-plant tests, and the general arrangement can be seen in Fig. 5, which shows the test setup. The base of girder construction resembles part of a main frame of a locomotive.

Besides the locomotive application, it is expected this unit will prove attractive for other applications such as for industrial power, automatic peak-load plants for power systems, oil-field or pipe-line applications, and so forth. It is expected that almost any liquid or gaseous fuel can be used. For some applications, steam might be produced from the exhaust gases. An outline of this plant used as an alternating-current-generator drive is shown in Fig. 6.

Preliminary studies indicate that this same unit can be adapted readily to a pulverized-coal-burning plant if and when the combustion and ash problems have been overcome.

To reduce costs to a reasonably low level, manufacture of identical units in fairly large numbers is essential, so it is expected gas-turbine plants, particularly the power units, will be standardized. Thus the power unit as shown in Fig. 6 is essentially identical with the unit applied to locomotives.

With the present methods of construction, it is expected that larger single-shaft units should present no unusual additional problems. Such larger units of this simple type may be developed later if they seem justified.

## COMPRESSOR DETAILS

The rotor of the 15-stage axial-flow compressor is built up of separate wheels held firmly together by through-bolts. The wheels are held concentric by the fits near the center. There are small gaps between them at the rim to eliminate, in so far as possible, any rotor bending effects which might be caused by local heating or rubbing.

The wheels of the first six stages are of aluminum alloy to reduce weight and rotating inertia. The design of the 13 per cent chrome-steel blading is based upon the well-known "vortex" principle with modifications. Some of the blades are machined from bar stock and some are forged. Fig. 7 shows a completed rotor, while Fig. 8 shows a bladed wheel and illustrates the dovetail arrangement. Each type of blade is used for several stages with the length being cut to suit.

This built-up rotor construction is somewhat similar to that employed successfully in previous designs for aircraft application. However, the present construction is considerably more

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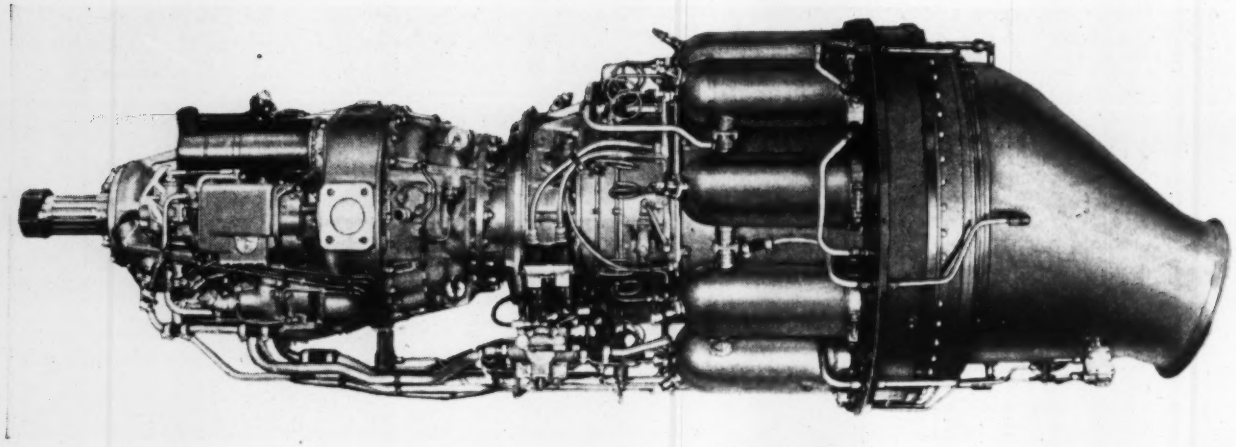

FIG. 1 AIRCRAFT GAS TURBINE FOR PROPELLER DRIVE, PROPJET, TG-100

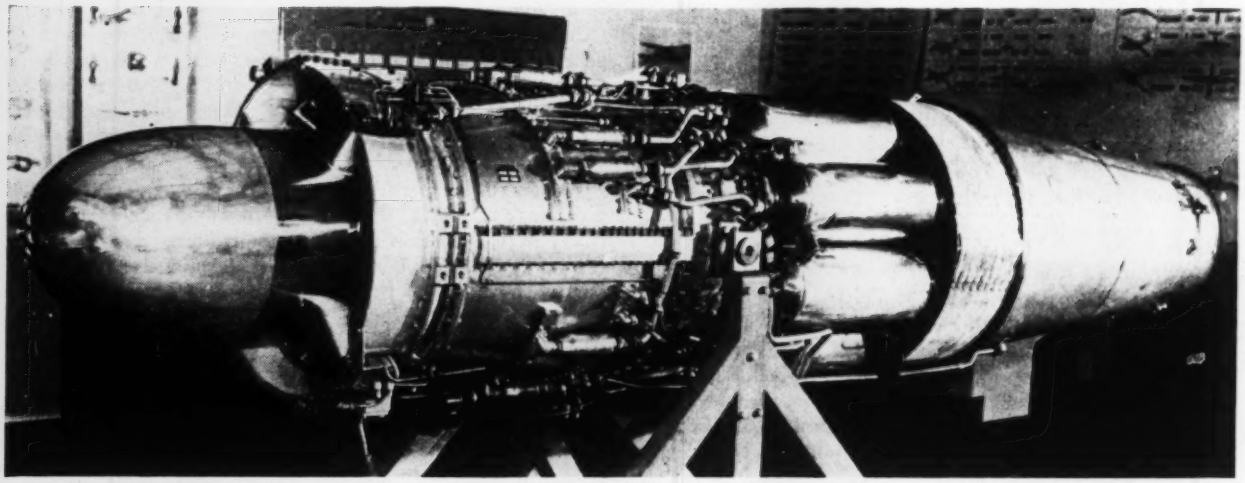

FIG. 2 AIRCRAFT GAS TURBINE FOR JET PROPULSION, AXIAL-FLOW TYPE, TG-180

rugged and also somewhat heavier, as seems reasonable for a nonflying application.

A bladed stator half is shown in Fig. 9, and the construction is also indicated in the cross section. Here the blades are held in half-rings by a means of dovetails similar to the rotor. These blade-carrying rings are slid into grooves in the stator casing.

The casing is composed of a front and a back half, bolted together. A nonsplit ring is incorporated in this joint to minimize distortions under transient conditions. It is assembled by sliding over the end of the rotor in preliminary assembly. The inlet half of the casing is of aluminum, and the discharge half is of steel, because of the higher temperatures. The compressor casing is split on the horizontal, but neither the aluminum inlet hood, nor the steel "mid-frame" to which the casing is bolted is split. It is believed that the nonsplit construction for these parts results in less distortion under changing conditions. The extraction is for turbine-wheel cooling air. No extraction for starting or other operating conditions is expected to be necessary and none is provided.

With the disk construction of the rotor, relatively high blade speeds can be employed with conservative wheel stresses. Therefore there is a relatively small number of stages, which results in a compact plant.

### COMBUSTION SYSTEM

The six combustion chambers are of all-metal construction generally similar to that developed for the aircraft units. The outer casing is of carbon steel, while the inner liner is of stainless material. These, together with a fuel nozzle, are shown in Fig. 10. Each liner is approximately 35 in. long and 10 in. diam.

Air enters the inner liner through the annular slits between the various sections, through radial holes and through louvers. With proper location of these slits, louvers, and holes, excellent combustion is obtained over a wide range with good stability and ignition characteristics, and with good cooling of the liner. Development of these chambers is still under way and further improvement is expected, although they now appear to have a reasonable life and to be generally trouble-free. Based on aircraft-unit experience, operation of the power plant will lead to still further improvements.

It is expected that the combustion system of this first unit will require more frequent scheduled inspection and possible replacement of some of its parts than will be the case after still further development.

The fuel nozzles are of the air-atomizing type, obtaining air from a small compressor driven from one of the pads of the accessory case located at the front of the unit.

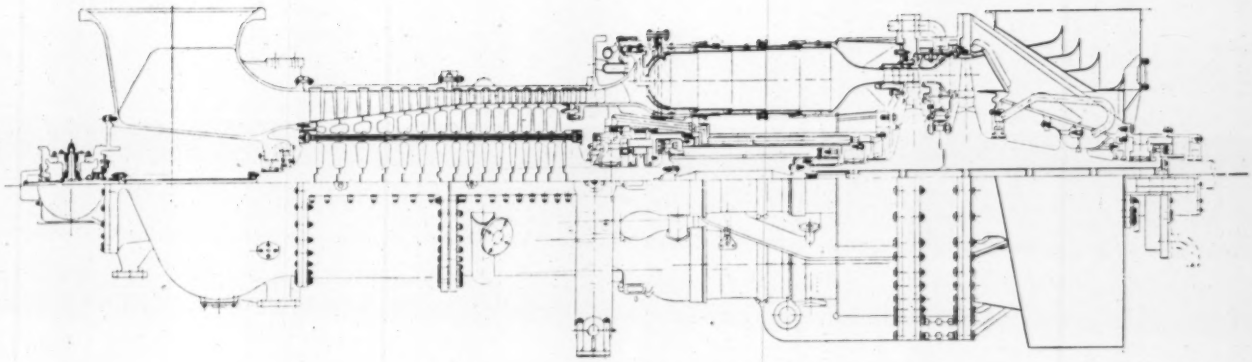

FIG. 3 SEMI-CROSS SECTION OF 4800-HP GAS-TURBINE POWER PLANT FOR LOCOMOTIVE DRIVE

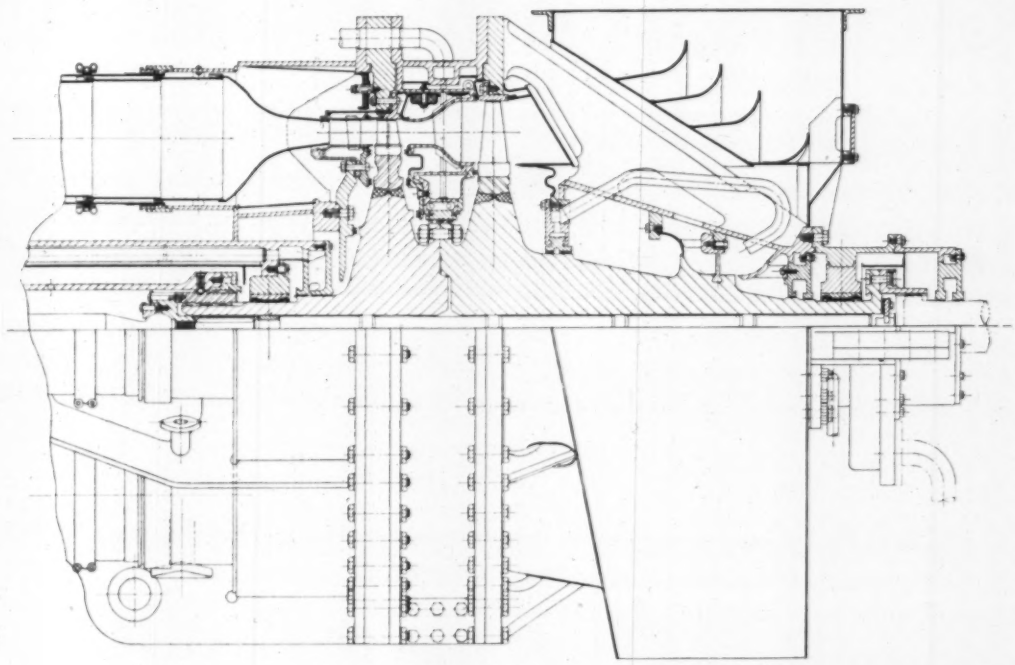

FIG. 3(*a*) DETAILS OF TURBINE END OF GAS-TURBINE POWER PLANT

Ignition is by means of spark plugs located in two of the six combustors. When these two chambers fire, the others are ignited through the cross-ignition tubes interconnecting the chambers at the forward end. Such cross-ignition tubes have been found quite desirable and satisfactory in aircraft units The present plan is to start the unit on Diesel fuel and to convert to bunker C fuel as idling speed is attained. Later, it may be found feasible to start directly with the heavy bunker C type of fuel. The bunker C fuel will be preheated to between 200 and 300 F before atomization, and will be cleaned by centrifuging or filtering.

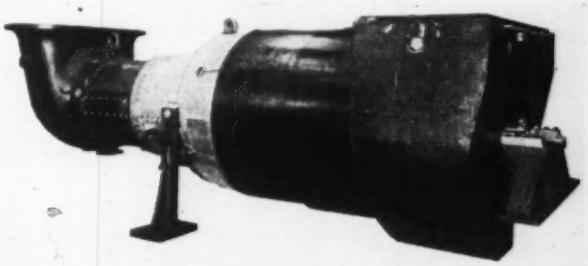

FIG. 4 GAS-TURBINE POWER PLANT FOR 4800-HP LOCOMOTIVE DRIVE

### TURBINE FEATURES

The two-stage turbine includes a number of interesting and somewhat unique features. For instance, two stages only are used rather than a multistage design. This is done for two major reasons; (1) the design is simpler and more compact, (2) the bucket temperature, especially of the first stage, is considerably lower than would be the case with a multistage design. Thus the calculated bucket pitch line temperature is 1160 F, with 1400 F inlet. If there were, for instance, eight full reaction stages, this bucket temperature would become about 1360 F or 200 F hotter.

Stated another way, the turbine-inlet temperature may be increased substantially for a given permissible bucket temperature. This increase is expected to more than offset any possible small reduction in turbine efficiency because of the two-stage design with impulse first stage.

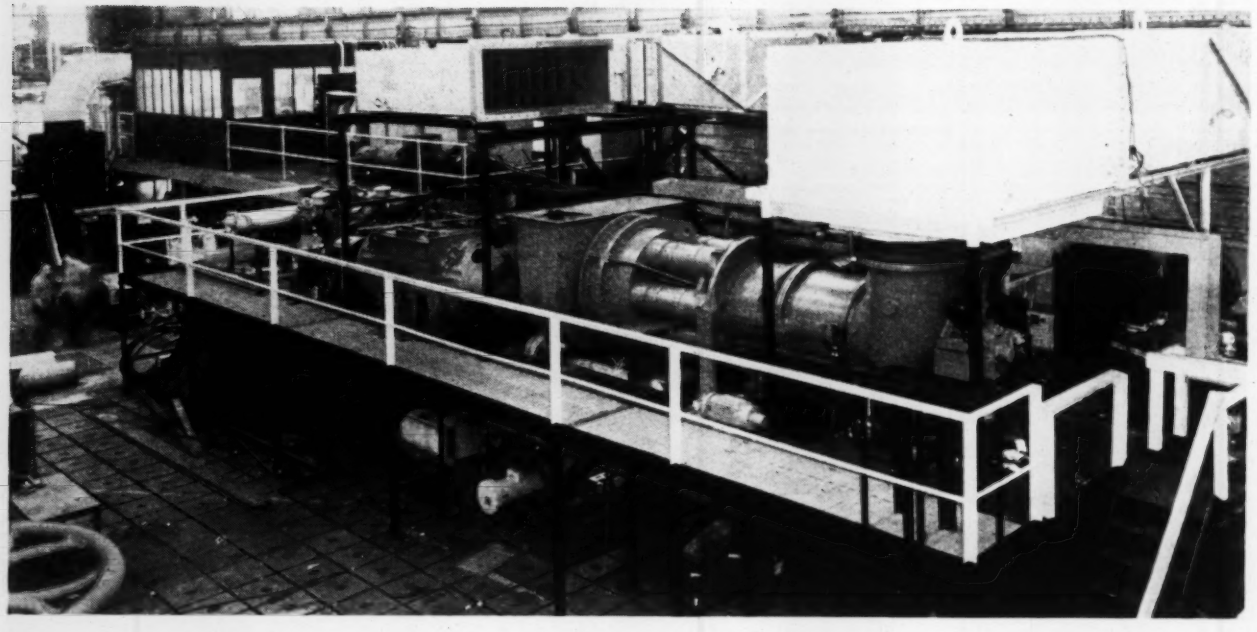

FIG. 5 GENERAL VIEW OF TEST INSTALLATION OF 4800-HP GAS-TURBINE POWER PLANT FOR LOCOMOTIVE DRIVE

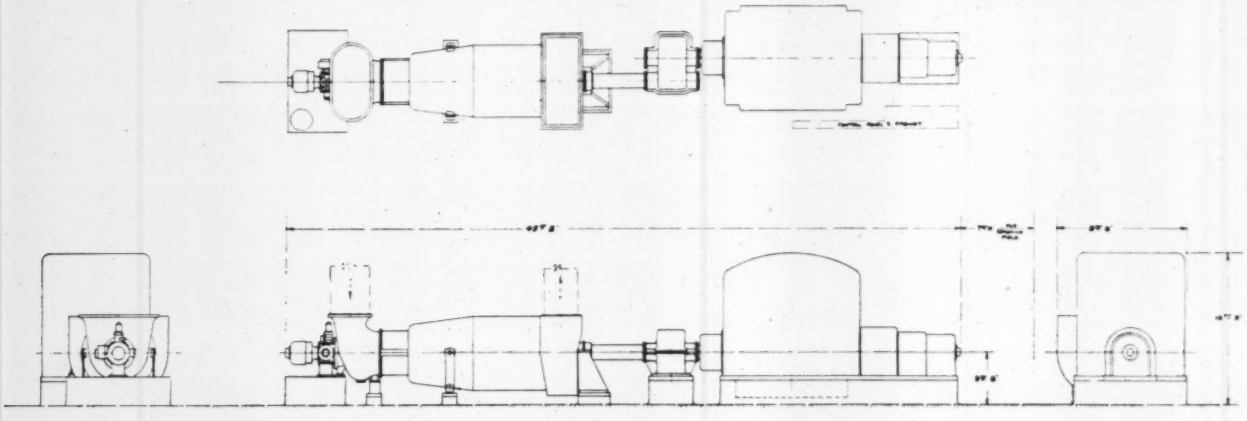

FIG. 6 3500-KW GAS-TURBINE PLANT
(Preliminary outline of 4800-hp gas-turbine power plant driving alternating-current generator.)

Another means of increasing the permissible turbine-inlet temperature is to decrease the turbine-bucket centrifugal stresses. This is done on the first stage by using fairly high axial velocities, resulting of course in a shorter lower-stress bucket.

For low leaving losses, the exit velocity from the second stage must be relatively low. Thus, there is a considerable step-up in radial height to the second stage. Special care is used in the nozzle design to obtain good performance.

In order to use a small number of stages, the bucket velocity must be higher than with a multistage design. This does not increase the bucket stress but does tend to increase the wheel stresses. This tendency is taken care of in two ways; (1) rather thick wheels are used, of approximately constant and moderate stress design, (2) a composite construction is used.

A unique feature of the wheels is this composite construction. The rim of the wheel is composed of stainless material suitable for high-temperature operation, while the main central portion of the wheel is composed of low-alloy high-strength steel, suitable for operation below 700 F. The rim is welded to the central portion as shown in the cross section. The two different materials may be seen in Fig. 11. This construction results in a wheel which is much stronger at the center than if high-temperature alloys were used throughout and is, on the other hand, much stronger at the rim than if low-alloy steel only was employed. This permits much greater freedom of design, and the manufacture of larger turbines operating at higher temperature than would otherwise be possible. The shaft is forged integral with the wheel center.

A vital question which naturally arises concerning this construction is the effect of thermal expansions. This composite construction has been used on a large number of aircraft units. A great many tests have been run simulating various operating conditions to prove out the construction. Several sample wheels have been heated by electric induction at the rim with the center maintained cool. The heating was carried to about 1400 F rim temperature, which is several hundred degrees hotter than the operating temperature, and

the whole wheel was then water-quenched. One wheel has been put through 100 cycles of this exceedingly severe treatment and has shown no signs of deterioration. Additional tests are being made, and careful observations will continue to be made in operation of the various plants using these wheels. However, all the indications are that this construction will be entirely satisfactory.

Both first and second-stage wheels are of similar construction and bolted together. A completed rotor is shown in Fig. 12.

The wheels are cooled by means of a small air flow bled into the space between the wheels and their adjacent stationary walls. The air is extracted from an intermediate stage of the compressor.

The buckets are fastened to the wheels by means of dovetails of the axial-entry type. These may be seen in Fig. 12. Bucket covers are not used on either stage, since, based upon our experience to date, it appears that, under the particular requirements of this type of gas turbine, a more desirable over-all result is to be expected without them. The effect on the efficiency and general operation of this particular type of turbine construction remains to be determined by further operational tests. In any case, a higher speed, and thus a more compact machine results from the coverless design if centrifugal stress at the root is a limiting factor.

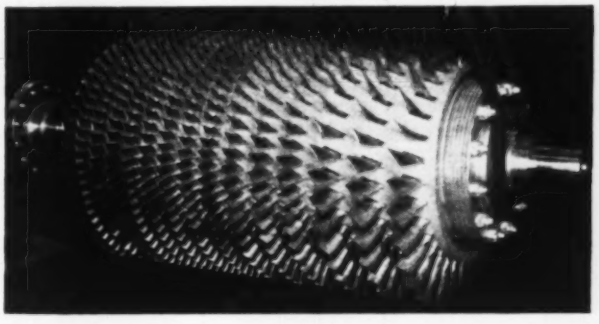

FIG. 7 ASSEMBLED COMPRESSOR ROTOR OF 4800-HP GAS-TURBINE POWER PLANT FOR LOCOMOTIVE DRIVE

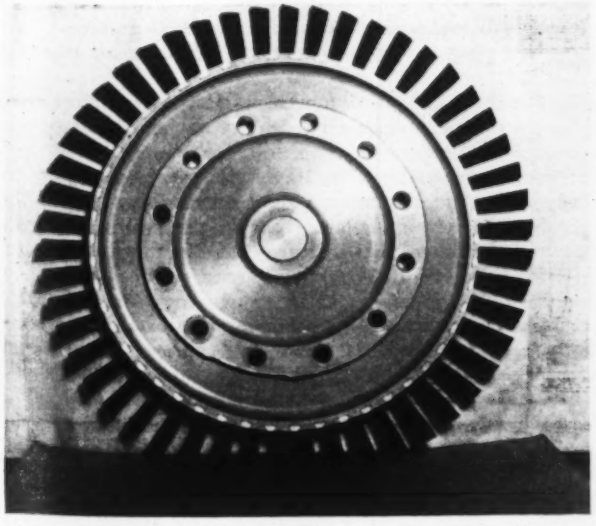

FIG. 8 GAS-TURBINE POWER-PLANT COMPRESSOR WHEEL WITH BLADES ASSEMBLED, SHOWING DOVETAIL ARRANGEMENT

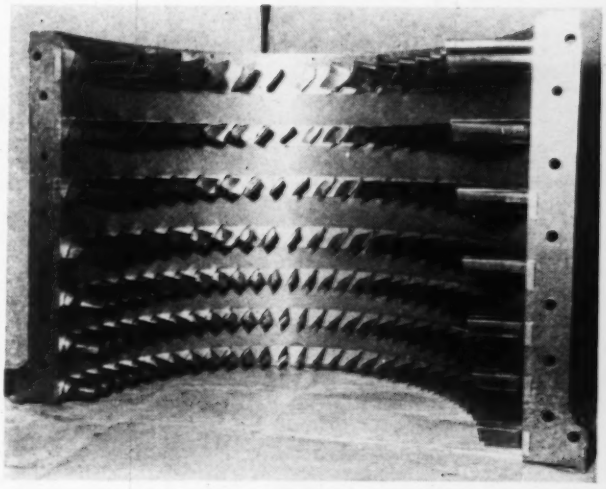

FIG. 9 PART OF COMPRESSOR STATOR WITH BLADES FOR GAS-TURBINE POWER PLANT

FIG. 10 COMBUSTION-CHAMBER PARTS SHOWING OUTER CASING, INNER CASING, AND FUEL NOZZLE FOR GAS-TURBINE POWER PLANT

The first-stage turbine nozzle consists of partitions welded into an outer ring, projecting through closely fitted holes in an inner ring. These nozzle rings are supported as shown in the cross section, Fig. 3, by two additional rings to which they are welded. This forms a structure somewhat similar to a bellows which is free to expand radially with the introduction of but small stresses. However, since the rings are all circular, the nozzle is maintained concentric, regardless of radial expansion. This is because a force pushing the nozzle ring upward, say, is resisted by a shearing action in the outer and inner rings at the horizontal. Thus, for concentricity, the nozzle is not springy as might be inferred from a first inspection of the cross section. In this way, allowance is made for the expansion of about 0.5 in. diam from the cold to hot condition without the use of pins or keys which might cause sticking or other uncertainties under these high-temperature conditions.

The second-stage nozzle is of somewhat similar construction but is split to permit assembly. Here the partitions are welded at both the inner and outer diameters. Pipes carry wheel cooling air extracted from the compressor through the nozzle partitions across the gas path to the packing.

The stator construction is based upon the use of rings op-

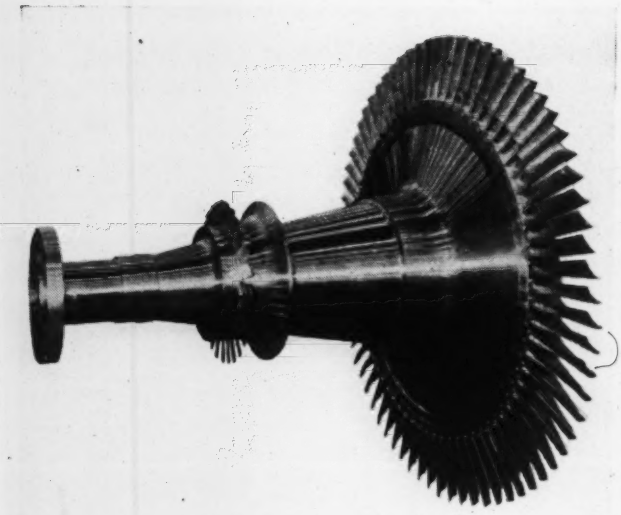

FIG. 11 SECOND-STAGE TURBINE-WHEEL OF GAS-TURBINE POWER PLANT SHOWING DOVETAILS, BUCKETS, COMPOSITE WELD, AND COOLING FAN

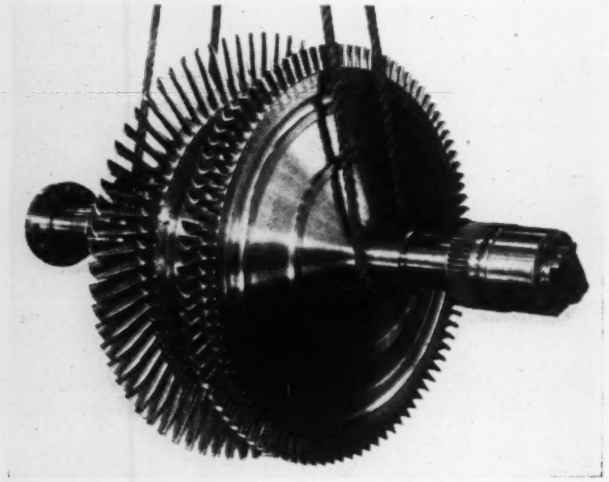

FIG. 12 ASSEMBLED TURBINE ROTOR FOR 4800-HP GAS-TURBINE POWER PLANT FOR LOCOMOTIVE DRIVE

posite each wheel which provide the main structural rigidity. These rings are of ordinary low-carbon steel and are complete circles with no horizontal split, to give circular symmetry and consequent freedom from distortion. L-shaped pieces of stainless steel, about 3 in. long tangentially, are bolted, as shown, at the inside diameter of these two rings and form the gas path and the surface opposite which the blade tips run. These individual pieces are held with one bolt each at the center, and when assembled have some clearance between them which is calculated to close up under operating conditions.

These main rings are insulated from the hot gases to a material degree both by the pieces just referred to and by the insulating pads. Furthermore, cooling air is drawn through axial holes drilled through these rings near the outer diameter. An outer shroud not shown, forces this cooling air, sucked by the fan on the turbine shaft, to go through the cooling holes.

With this turbine-casing construction, the amount of expansion is greatly reduced over the more conventional construction where the turbine casing is of stainless steel and reaches about full gas temperature. Both the low temperature and the relatively small coefficient of expansion of ordinary steel contribute to this result.

The main rings are bolted to the turbine casing which is also made of ordinary steel and is insulated and cooled in a manner similar to the rings.

The aft ring is welded to six struts which pass through the exhaust casing to carry the aft bearing. The cooling air previously referred to is drawn past these struts through the hollow streamline passages in the exhaust hood. Thus these struts will remain quite cool and should be uniform in temperature. If they passed directly through the hot gas they would have much greater expansion and this might be nonuniform, especially if all combustion chambers did not, for some reason, operate exactly alike. The cooling air is discharged through the main exhaust.

The exhaust hood is fabricated from low-carbon sheet steel. Parts of this exhaust casing are being corrosion-protected by different methods to determine whether protection is necessary, and if so, what would be the most satisfactory treatment.

The turbine is in general assembled axially, except for the second-stage diaphragm and its outer supporting flanged rings which are split and assembled radially. No other parts of the turbine are split.

### CONTROL AND ACCESSORIES

The accessories are driven from the accessory gearbox mounted on the front of the unit. These include a tachometer, overspeed governor, fuel pump, atomizing air compressor, lubricating-oil pump, and fuel regulator.

The fuel regulator performs the control functions of maintaining speed and power output, limiting the exhaust temperature, and so on. It does this primarily by varying the fuel flow by controlling the position of a plate in the fuel pump which in turn alters the piston stroke. This fuel regulator is of the electrohydraulic type, and is similar to that on which considerable experience has been obtained from many Diesel-locomotive applications. In general, the operating functions are performed by hydraulic means, while the required input information is transmitted to the regulator by electrical means. This combination results in a small and reliable regulator, coupled with the great convenience and adaptability of the electrical transmission of information. This same control with minor modifications is suitable whether the power plant is used as a locomotive drive or for other applications.

Besides the usual control functions and overspeed protection, there are temperature-sensitive devices in the exhaust to prevent excessive temperature.

The machine is started from a control panel; the operation is semiautomatic, depending partly on the discretion of the operator. It is contemplated that in the near future fully automatic starting will be developed. In a locomotive application, the required starting power would be obtained from a Diesel-engine generator set supplying power to one of the main generators. In other applications, a starting motor will be provided, driven by whatever means seems appropriate.

The starting power required will depend materially on the temperature to which the power plant is fired under starting conditions. The lower this temperature is the less severe will be the temperature shock during starts, with consequently increased life, but the larger the starting power required. Tests will be necessary to determine the various factors involved. However, it appears that a shaft input to the power plant of around 100 hp should result in satisfactory starts.

# ADVANCES *in* RUBBER *During* 1947

By V. A. COSLER and S. W. McCUNE, 3RD

RUBBER CHEMICALS DIVISION, E. I. DU PONT DE NEMOURS & COMPANY, WILMINGTON, DEL.

THE enactment of Public Law No. 24, early in 1947, by the Eightieth Congress, was an important step in the formation of a national policy on rubber. This legislation authorized the continuation of the wartime industry controls until March 1, 1948, so that permanent legislation could be prepared which would establish a long-term policy on rubber as a national security measure (1, 2).[1] The establishment of a permanent synthetic-rubber program has been encouraged by the rubber-manufacturing industry (3, 4, 189). The consumption of natural and synthetic rubber continued at a high rate during 1947, and the prospects of the future indicate that this rate of consumption may be continued (5, 6, 7, 185, 186). Free commercial trading was resumed in natural rubber and increased quantities have been available. In many products the use of natural rubber is unrestricted and some natural rubber may be used in the manufacture of all types of finished products.

## RUBBER PRODUCTION

The development of a new chemical industry, capable of producing synthetic rubber at a rate of 1,000,000 long tons per year, has been described in a review of the governmental activities in the production of synthetic rubber (184).

Improved processes for the preparation of crude rubber have been developed which employ continuous coagulation of hevea latex (8). Research in the development of rubber-bearing plants has been continued under government sponsorship (9). A summary has been prepared which describes the properties of the various grades of plantation and wild rubbers (41, 188).

A continuous process has been developed for the isolation of GR-M from latex (10). GR-S polymers may be divided into seven different groups according to their composition and properties (11), and synthetic latices may be classed into four distinctly different types (12).

## RESEARCH AND DEVELOPMENT

The vulcanization of rubber with sulphur has been reviewed from a theoretical and practical point of view (13). New studies have been made of the sulphur linkage in vulcanized rubber (14, 194) and the change in properties which rubber undergoes during cure (15). Phenol-formaldehyde derivatives have been evaluated as vulcanizing agents for rubber (16). Vulcanization by the Peachey process, involving alternate exposure of specimens to sulphur dioxide and hydrogen sulphide resulted in good cures of compounds of all types of synthetic rubber with the exception of GR-M (17). The chemical structure of certain organic accelerators was studied in the light of their effect upon rubber vulcanization (18).

The oxidation of rubber has been investigated from a kinetic point of view (19) and new data have been developed on the rate of the rubber-oxygen reaction (20). The factors affecting the aging of vulcanized rubber have been reviewed and methods of preservation of rubber products developed (180). Measurements of the thermal decomposition of various rubber compositions in air show that exothermic decomposition takes place when compounds are heated rapidly to a temperature of 300 C (21). An evaluation of the effect of copper on the accelerated aging characteristics of neoprene has led to the development of methods of minimizing its effect (22).

Further support has been given to the theory that the cracking of stretched rubber during outdoor exposure is due to atmospheric ozone (23). Other factors affecting the oxidation of GR-S have also been evaluated (24, 25, 26).

Study of the structure of long-chain polymers as revealed by x rays has been continued by physicists (195).

The electrical conductivity of natural rubber and GR-S compounds containing acetylene carbon blacks, has been measured (174). The dielectric properties of mixtures of polystyrene and polybutadiene, as well as other rubber compounds, have been studied (175, 176). The heat conductivity of various rubber compositions has been investigated over a wide temperature range (43).

Permeability of rubberlike materials to gases has been described in terms of the solubility and diffusion of the gas in rubber (27, 28, 29).

Determinations of the swelling of natural and synthetic rubber compounds, when immersed in various organic liquids, have provided valuable comparative data (30). The solubility of unvulcanized rubbers in hydrocarbons is indicative of the effect of solvents on the vulcanized elastomer (191). The effect of various types of carbon blacks upon the swelling properties of different synthetic rubbers has been the subject of several investigations (31, 32, 33).

Synthetic rubbers have been tested for fabric-to-fabric adhesions (183).

A review of the factors influencing the strength of a rubber-brass bond presented evidence that the bond was a physical one rather than a chemical one (34). Improved methods of bonding rubber to metal have been developed (192, 193).

The rubber-reclaiming industry has continued its efforts to improve the properties of reclaimed rubber. Experiments have resulted in the development of a method for estimating the quantity of GR-S in rubber reclaim (35). Studies of the chemical reactions which take place during the reclaiming of rubber have continued (36, 179). New chemicals for the reclaiming of rubber have been developed (37). A comprehensive treatise has been prepared covering the history of reclaimed rubber, methods for its manufacture, its properties and uses (38).

The activities of the National Bureau of Standards in evaluating and testing rubberlike materials have been reviewed. A bibliography lists all the publications by this Bureau on the subject of rubber (40). Methods for the evaluation of small quantities of synthetic polymers have aided the research in the improvement of synthetic rubber (42).

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Rubber and Plastics Division and presented at the Annual Meeting, Atlantic City, N. J., December 1–5, 1947, of The American Society of Mechanical Engineers.

The stability of polychloroprene dispersions and neoprene latices at low temperatures and in the presence of acidic materials has been the subject of considerable research (44 to 47).

Polymers of the GR-S type which have low-water-absorption properties have been developed for use in wire and cable insulation (48, 49).

The importance of fatty acids and their soaps in the manufacture of synthetic rubber has been described (50), and data have been published on the action of hydroquinone as an inhibitor of polymerization (51). New mercaptans have been evaluated as modifiers for GR-S (181).

Methods have been developed for concentrating GR-S latex (52, 177). GR-S polymers have been fractionated and the physical properties of the various fractions determined (53). The properties of substituted GR-S polymers have also been determined and compared with those of standard compounds (54, 55).

The use of fluorocarbons as dispersing media has made possible the emulsion polymerization of isobutylene (56).

Additional information has been made available about the properties of Lactoprene, a polymer of ethyl acrylate and chloroethyl vinyl ether, and processes for its manufacture on a semicommercial scale have been developed (57, 58).

### DEVELOPMENTS IN RUBBER

The properties of rubber which are of special interest to engineers include the design factors of elastic materials which are applied to isolate, transmit, or support various loads or forces and the factors involved in the use of rubber in tension (59, 60, 61). The use of rubber parts in springs for commercial vehicles has increased (62–67).

Reports have been published on the performance of neoprene in experimental tires (69) and on the use of all synthetic rubbers in tires and tubes (68). The use of butyl inner tubes is claimed to result in increased tire life (70). The use of synthetic rubber in tires was furthered by an investigation of the frictional properties of tread compounds on ice (71).

Tires containing wire-cord reinforcement have been produced on a commercial scale and have proved advantageous in off-the-road service (72). Experimental tires have been built using glass-cord fabric as the reinforcement (73).

Heating and drying applications represent successful practical uses for electrically conducting rubber compositions (74 to 77).

The factors which influence the backrinding of molded rubber products have been investigated and suggestions made for minimizing its occurrence (78). Injection-molding procedures have been developed for the production of large parts (79) and an improved method has been devised for molding rubber printing plates (80).

An investigation has been made of the frictional properties of oil-seal materials (101).

Advances in latex technology have resulted in the development of a wide variety of new applications such as binders and impregnants for fibrous materials, rubber linings and coatings in which synthetic-rubber latex compositions have been used (82 to 84). The use of rubber linings and coatings for the protection of metal equipment has expanded (81, 85 to 89).

Improvements in the properties of high-temperature-resistant synthetic compositions have widened their use (90 to 96).

Interest has been renewed in the use of rubber compositions as joint fillers for concrete pavement (97 to 99).

A method has been developed for the precision machining of rubber parts by freezing them (100).

### TESTING IMPROVEMENTS

A great deal of information has been published during the year about methods of test.

Improved methods have been described for the chemical analysis of synthetic rubber (102), the determination of the rubber hydrocarbon (103), and the copper content of crude rubber (104).

Procedures for testing rubber in government laboratories have been improved and standardized (105, 187). Greater accuracy has been attained in the stress-strain testing of rubber compounds (110). Statistical analyses of the results of laboratory tests on rubber have thrown new light on the reproducibility of various tests (106–109). A correlation has been determined between the tensile strength and the brittle point of vulcanized polymers (111). An investigation of the effects which buffing of a tensile specimen had upon the test results led to the development of a new buffing machine (112). Better equipment for the stress-strain testing of rubber has been developed (113).

The effect of the rubber surface on hardness measurements made by a ball-indentation method has been reported (114).

A simple cold test for vulcanized polymers measures primary creep at successively lower temperatures by means of a durometer or other hardness tester (115). A new laboratory test for measuring stiffness at low temperature measures the angle of twist produced in a sample by a constant torsional force applied at various temperatures (141). Another method evaluates flexibility at low temperature by stress-strain measurements (142).

The abrasion resistance of rubber has been studied from the point of view of correlation of laboratory measurements with service wear. A survey of a number of tests showed that fair correlation was obtained between laboratory abrasion tests and tire-tread performance (116). Extraction of abrasion-test samples gave better correlation between laboratory tests and service performance (117). New equipment for abrasion testing has been developed (118). Factors influencing the results of tests for abrasion resistance have been discussed (119).

A study has been made of methods proposed for measuring tear resistance (120), and procedures for improving the precision of tests for tear resistance developed (121, 122).

Testing of rubber for cut growth was reviewed (123). A new method has been devised for measuring the heat embrittlement of natural and synthetic rubber compounds (124). A critical review and discussion of the present knowledge of hysteresis and methods for its measurement in rubber was presented (125), and other studies of the dynamic properties of rubber described the measurement of vibration fatigue (126) and the effect of temperature on resilience and elastic losses (127 to 129).

Improved methods have been developed for evaluating the surface-cracking characteristics of rubber compositions when exposed to light (130, 131).

Comparisons of the effects of accelerated aging of GR-S and rubber in an oven and oxygen bomb paid particular attention to the effect which temperature and oxygen concentration had upon physical properties (132, 133).

A method of measuring the resistivity of conductive rubber gives results that may be used as an indication of the relative value of compounds in actual service (134).

A method of measurement of the adhesion of unvulcanized rubber to metal was obtained by observing the angle at which a metal ball rolls off a rubber surface when it is tilted (135).

The velocity and attenuation of sound in rubber strips were measured by the standing-wave method (136).

Determination of the rate of breakdown of rubber and GR-S can be made with a Brabender plastograph (137). A Mooney plastometer can be used to determine the scorch characteristics of rubber stocks and the rate at which vulcanization proceeds beyond this point (138).

Standard tests have been developed to evaluate the processability of rubber compounds (139).

Measurements of creep were used as a means of determining the behavior of antioxidants and accelerators in natural rubber and GR-S (143).

Laboratory methods have been developed for the evaluation of rubber torsion springs (144, 145).

### COMPOUNDING INGREDIENTS

The effectiveness of softeners and plasticizers in GR-S continued to occupy the attention of a number of investigators. One study of the effect of plasticization on the properties of synthetic rubber divided softeners into solvent and nonsolvent types (146). A comparison of tire performance with the results of laboratory tests indicated that the latter are useful for selecting softeners for tire compounds but cannot be used for the precise prediction of their road performance (147). Silicone oils, although incompatible with rubber, are said to increase the resistance to abrasion of vulcanized compounds (148). The cloud points of various coumarone-indene resins have been correlated with their effectiveness as softeners for rubber (149). Low-molecular-weight polyisobutylenes are reported to plasticize natural rubber and GR-S and to shorten the milling time required for the incorporation of fillers and other ingredients (166).

A variety of materials have been evaluated as plasticizers for nitrile-type synthetic rubbers and blends of them with vinyl resins (150 to 152). A graphical method has been suggested for presenting data on the performance of plasticizers in synthetic rubber (153).

Research on carbon blacks and their effect upon the properties of rubber compositions has continued to be important. Several investigations have compared the performance of furnace-type carbon blacks with that of the channel-type blacks (154 to 158). The effect of channel carbon blacks on the processing characteristics of synthetic rubber has been evaluated (159). Further studies have been made of the structure of the carbon-black particle, its oxygen content, and oxidation characteristics (160, 161).

Copolymer resins containing high proportions of styrene are valuable as reinforcing agents for nonblack rubber compositions (162, 163), and water dispersions of these resins may be used in compounding latex (164).

Organic fungicides have little effect upon the properties of natural or synthetic rubber but organic-copper compounds do affect their aging characteristics (39).

Wood cellulose and lignin have been investigated as compounding ingredients for rubber (165, 183) and phenolic resins are reported to improve the oil and heat resistance of synthetic-rubber compositions and to increase their tensile strength and hardness (167).

Nitrile-type synthetic rubbers are reported to be effective plasticizers for vinyl resins (166 to 172) and several mixtures of these materials are being produced commercially.

### SUMMARY

A résumé of the advances made in rubber technology during the year 1947 shows that, even with the increased consumption of natural rubber, a considerable proportion of the research and development effort of the rubber industry has been directed toward improving the properties of synthetic-rubber products. There has been an increased interest in the testing of rubber products, and a noticeable trend toward the experimental evaluation of finished products under simulated service conditions (178). Thorough determinations of the properties of new polymers and compounds have revealed characteristics in synthetic-rubber compositions which make them better suited to certain applications than products made from natural rubber (190).

These developments have gone a long way toward overcoming the original prejudice against synthetic-rubber products as temporary substitutes and have resulted in their acceptance by users on the basis of their merits.

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# FLOW *of* COAL *in* CHUTES

By E. F. WOLF[1] and H. L. von HOHENLEITEN[2]

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IN 1945 the authors presented before the ASME the results[3] of physical tests of the flow characteristics of coal in chutes, together with the development of scale models of coal chutes. A design was developed in the laboratory tests and one experimental chute was installed at Riverside Station. This chute has been in operation for approximately 2 years and, due to its experimental nature, has been subjected to close scrutiny. This article is presented to report observations made on the correlation between field experience and laboratory tests, and the further developments based upon these observations.

As outlined in the paper,[3] the development of a new design of chute was at best difficult since obstructions due to location of air preheaters, gas ducts, and main structural framing members could not be overcome, and the path for the chutes was therefore rather closely defined. Furthermore, the problem involved the flow of coal by gravity through a vertical distance of approximately 50 ft from two large bunker openings, 8 ft apart, to one comparatively small mill-feeder inlet.

## SERVICE RESULTS FOLLOW MODEL STUDIES CLOSELY

In general, the flow characteristics of coal in the actual chute have been quite similar to those observed in the scale model. The "breakaway" which was discussed in detail in the paper duplicated itself in every respect in the full-sized chute, even to the pulsating movement of coal at the breakaway section. However, certain phenomena were observed in the scale model, the importance of which was not fully visualized from the small-scale experiments. For instance, in the hopper below the operating level (elevation 31 ft 6 in., Fig. 1), the coal showed a tendency in the model to drain somewhat faster along the vertical side than along the sloping side, as shown in Fig. 2. In the prototype, this tendency was emphasized and occasionally resulted in a rapid draining of coal along the vertical side, followed by a collapse of the wall of coal from the opposite side of the hopper. This collapse with its sudden movement of coal sometimes caused compacting of the coal into a plug which blocked the flow into the mill feeder.

In any coal system there is some point at which stoppage occurs when moisture content becomes sufficiently high. In this particular system, a critical point is at the converging section marked "X" in Fig. 1. This was a critical point in the model tests and, with relatively high moisture content, stoppages have occurred at this point in service. Since this location is not at the operating level, there is, of necessity, some time interval between a stoppage and its relief. In every case the stoppage could be relieved readily. On account of the streamlined design of the chute system and the absence of dead points or pockets, the coal would start to flow with considerable velocity when the stoppage was relieved and would sometimes cause either compacting just ahead of the feeder or flooding of the mill.

The hopper sections of the experimental chute were constructed of 20 per cent stainless-clad steel, and the cylindrical pipe sections were constructed of flange-quality carbon steel. The stainless-clad steel was used in the hopper sections, where compaction occurs, to obtain the advantages of its lower frictional resistance and its expected greater resistance to corrosion and erosion. The stainless-clad-steel sections have shown no appreciable wear after 2 years of service whereas the carbon steel has shown fairly rapid corrosion and erosion where exposed

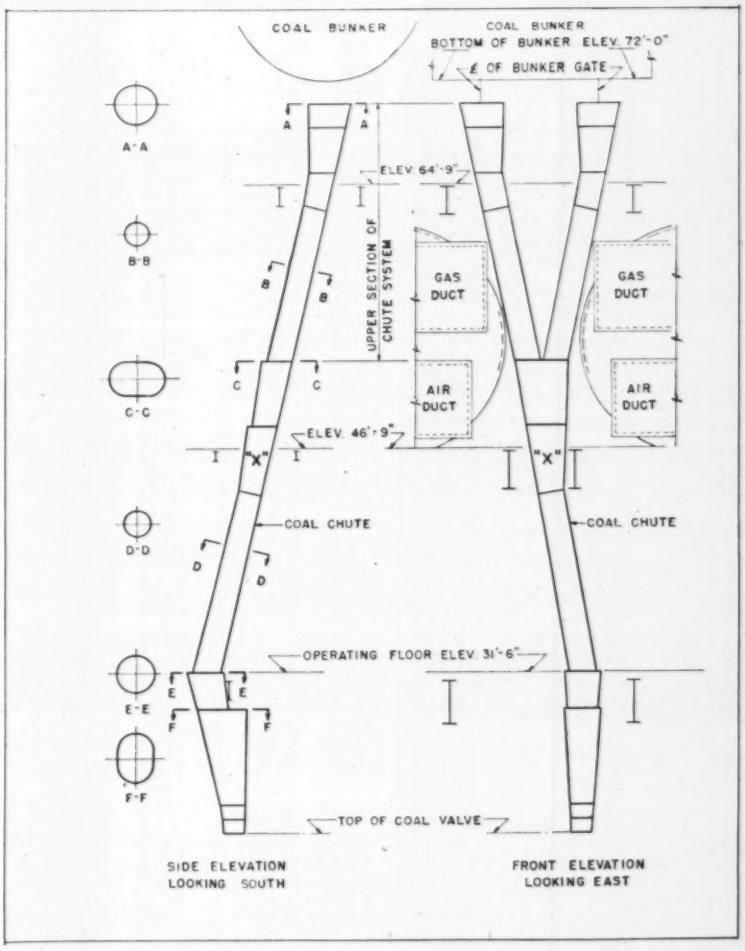


FIG. 1 GENERAL ASSEMBLY OF NEW COAL CHUTE CONSTRUCTED ENTIRELY OF ROUND OR OVAL SECTIONS

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[2] Senior Engineer, Electric Engineers Department.

[3] "Experimental Study of the Flow of Coal in Chutes at Riverside Generating Station," by E. F. Wolf and H. L. von Hohenleiten, Trans ASME, vol. 67, 1945, pp. 585–599.

to comparatively high velocity of coal flow in the cylindrical sections.

One of the most favorable observations on the experimental chute has been the influence of the design of the upper hoppers on the flow of coal from the bunkers. The flow from the bunker has been materially improved by this design since there are no dead pockets in the path of the coal flowing from the bunker gates and consequently does not cause backing up and arching of the coal from these dead pockets (see Fig. 3). This has resulted in less ratholing in the bunker above these chutes as compared to the similar section above the older chutes. Of further advantage is the fuller utilization of the bunker gate opening.

Due to the elimination of dead pockets and the minimum of compaction which had been achieved in the experimental design, it was observed that the upper portion of the coal-chute

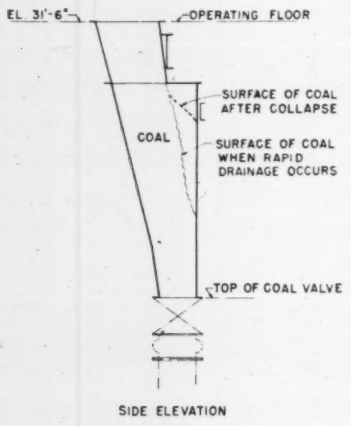


FIG. 2 HOPPER BELOW OPERATING FLOOR

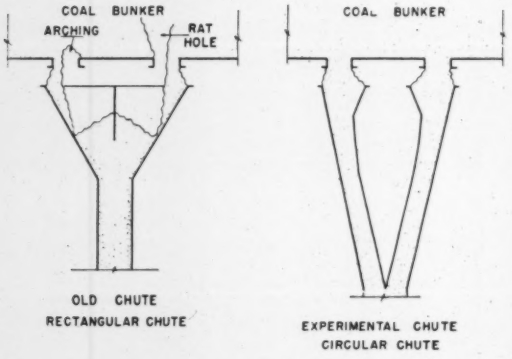


FIG. 3 DEAD POCKETS ARE ELIMINATED BY USE OF NEW CHUTE

system (from bunker gates to hoppers at *X*, Fig. 1), has been entirely free from stoppages.

### IMPROVEMENTS FROM USE OF EXPERIMENTAL CHUTE

The observed improvements obtained by the experimental chute may be summarized as follows:

1 Improvement of flow of coal from the bunker due to the better design of the upper hoppers.

2 Elimination of stoppages in the chute system at the highest elevations.

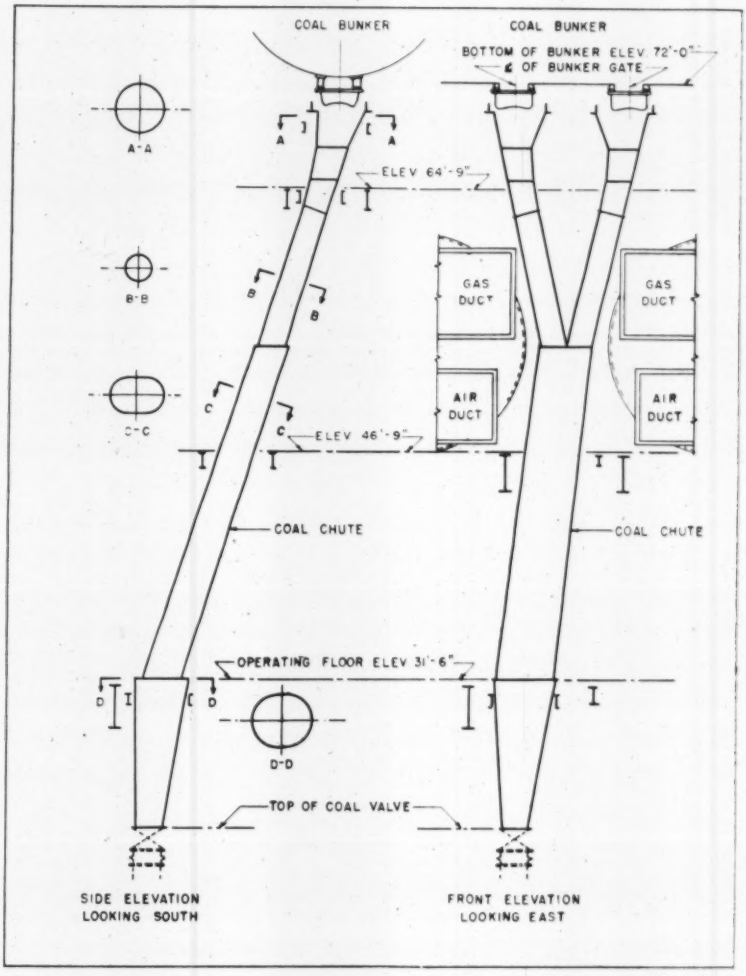


FIG. 4 GENERAL ASSEMBLY OF CENTER COAL CHUTE RIVERSIDE UNIT NO. 3

3 Greater ease of relieving stoppages when they occur in the lower and intermediate hoppers on account of the lesser amount of compaction of the coal in this chute system; this is accomplished by a smaller amount of reduction in cross-sectional area from top hoppers to mill-feeder inlet.

4 Full utilization of chute system.

5 Very little wear in sections where stainless-clad material has been used.

From the experience gained in the operation of this experimental chute, it is apparent that the quantity of coal available in the chute system must be sufficiently large to give the operator a chance to relieve any possible stoppage before the mill runs out of coal. It may become necessary therefore to sacrifice some of the better flow characteristics in order to gain this capacity. Another practical observation is the desirability of designing the coal-chute system so that the anticipated trouble points are located where they are readily accessible to the operator.

The importance of giving due consideration to the coal-chute layout in the early stages of planning the arrangement of equipment and structures should not be overlooked.

### DESIGN OF CHUTES FOR RIVERSIDE UNIT NO. 3

In formulating the design of the experimental chute, the limitations, previously mentioned and again pointed out in this

(*Continued on page 335*)

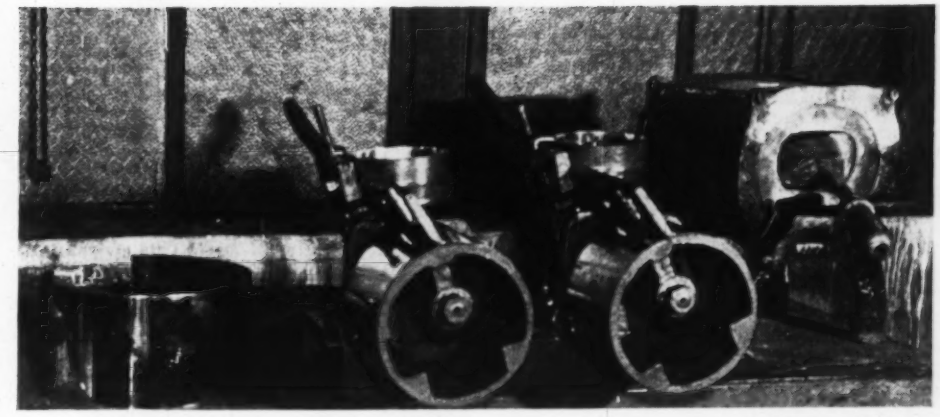

FIG. 1 JONES BLOCK—AN EARLY CAN BODYMAKER, SHOWING PRECURLED BODY, CLAMPING DEVICE, AND SOLDERING TOOLS

# ENGINEERING *the* TIN CAN

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CHIEF, CONTAINER RESEARCH SECTION, RESEARCH DIVISION, AMERICAN CAN COMPANY, MAYWOOD, ILL.

THE manufacture of tin-plate containers for food and non-food products has grown over the past 50 years into a healthy giant which consumes 4 per cent of the nation's finished steel production in the form of tin plate and black plate. A total of 2,760,000 tons of sheet steel was consumed in 1946, in the manufacture of metal cans (1)[1] which, on the basis of a standard No. 2 can, would amount to 22 billion cans. The qualities of the metal container contributing to the rapid growth of the industry are lightness, attractiveness, protection from light, freedom from breakage, and ease of handling in automatic canning lines at high rates of speed. It is the purpose of this paper to describe briefly the engineering phases of canmaking which have made it possible to meet the needs of the packaging industry, and finally to discuss the steps taken toward the conservation of tin which, in a large measure, may become permanent in the future of the industry.

## HISTORY OF CANMAKING

In 1810 Peter Durand (2), an Englishman, obtained a patent for a vessel of tin which he introduced into the art of preserving food. The canister, or as it was later shortened to "can," was made by cutting out the bodies and ends with tin shears from 14-in. × 20-in. sheets of tin plate, soldering by hand the side seam and end seams. A circular hole was left in the top for introducing the food. After filling and exhausting, the hole was closed by soldering a tin-plate disk in place. In these early days, each canner made his own cans; food was preserved during the summer months and cans were manufactured during the winter months. An expert canmaker could produce as many as 5 or 6 cans per hr, consuming upward of 25 lb of solder per thousand cans.

About 1847 Henry Evans (3) was granted a patent covering a pendulum press which, with William Numsen's combination die, could make a complete can end in a single operation. A little later, fixtures known as Jones' blocks, Fig. 1, were devised to hold the can body in position while soldering the side seam. Developments during the 1860's included improved methods of casting solder into continuous bars and wire. Segments of wire solder would be bent into $^1/_2$ or $^1/_3$ of a circle which permitted the application of the correct amount to solder a single side seam, can end, or cap.

Howe (3) introduced a floater in 1876 consisting of a long solder bath in which the end seams were soldered by dipping as the cans rolled along at an angle. The angle of 22 deg to the horizontal is still maintained in the manufacture of vent-hole milk cans; the only remnant of the hole-and-cap era. With these improvements, the number of cans per hour was increased to 50 or 60. The period 1880 to 1900 witnessed the development of the semiautomatic turret type of bodymaker having a series of solder horns onto which precurled bodies were fed by hand, soldering of the side seam being automatic as the turret revolved step by step at the will of the operator. The number of cans was thus increased to 2500 per hr.

The lock-and-lap side seam, although first introduced in Germany about 1870, was not fully applied until the 1890's, when machinery was developed to make a can automatically from a sheet of tin plate. The Norton Brothers developed one of the first complete systems and speeds were advanced to 6000 cans per hr. Between 1900 and 1910 the sanitary can was developed consisting of a soldered lock-and-lap side-seamed body with double-seamed end. This new construction largely replaced the all-soldered can by 1920.

## MODERN CANMAKING

The advantages of the sanitary can over the hole-in-cap can, of filling through the open top and closing without soldering, have contributed to the rapid growth of the industry. Continued improvements in canmaking have gradually advanced the number of cans to 20,000 per hr. Current solder consumption for No. 2 cans is less than 1 lb per 1000 cans. Present-day canmaking involves the following operations, some of which are indicated in Figs. 2 and 3:

[1] Numbers in parentheses refer to the Bibliography at the end of the paper.

Contributed by the Metals Engineering Division and presented at the Spring Meeting, New Orleans, La., March 1–4, 1948, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

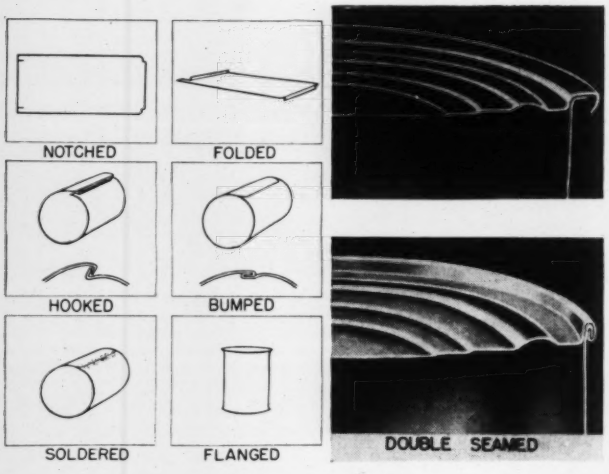



FIG. 2 CANMAKING OPERATIONS

*Bodymaking:*

1 Enameling the tin plate in the flat with cut rolls to provide plain plate for solder margins and laps.
2 Slitting tin-plate sheets into can-body blanks.
3 Automatic can bodymaking, comprising notching to permit double-seaming only two thicknesses of tin plate, forming side-seam hooks, fluxing, bumping, soldering, wiping excess solder, and finally cooling.
4 Flanging ends of body cylinder.
5 Double-seaming on bottom end.
6 Automatic testing under vacuum or air pressure.

*End Making:*

1 Enameling tin plate.
2 Scroll shearing strips from flat plate.
3 Forming ends on single or double die presses.
4 Curling flange.
5 Compound lining.
6 Double-seaming bottoms onto can bodies.

A modern can bodymaker is shown in Fig. 4.

## CANMAKING MATERIALS

The raw materials used in the manufacture of metal cans must pass exacting performance standards to meet the requirements of containers for the many types of packaged foods and nonfood products. Tin plate, can enamels, and sealing compounds are the essential materials, and this section will be devoted to the engineering problems arising in adapting these materials to the making of cans.

*Tin Plate.* Tin plate is admirably suited to canmaking because of its attractive appearance, strength, corrosion resistance, lightness, and, most important, low cost. The most essential requirements of tin plate for cans are corrosion resistance and strength.

## CORROSION RESISTANCE

The useful life of canned foods depends on many factors and, frequently, internal corrosion of the container is the limiting one. All processed foods react with the container to some extent and ultimately will render it unsalable by producing the small quantity of hydrogen necessary to cause distention of the ends. However, in practice, the corrosion problem has usually been critical only for certain classes of foods, notably fruits, and the present-day tin-plate applications are the result of more than 30 years of investigation in this field.

In brief, the corrosion work of the past years shows that the successful use of tin plate in the food industry depends on the fact that within a container tin is capable of furnishing the same type of sacrificial protection to the steel as galvanized coatings do under atmospheric conditions. The extent of this protection depends in part on such factors as the amount of tin and its continuity, but to a greater degree on the efficiency with which the small ever-present areas of exposed steel are protected. This is never fully effective and may be varied from near perfection to virtually none, by altering the nature of the steel alone. Naturally, interest in tin plate from the corrosion viewpoint has been centered on the steel, and it was through this means that commercial control of the problem was achieved.

In spite of the knowledge accumulated prior to 1930, effective commercial progress dates from that time with the establishment in 1932 of the first chemical specifications to control the corrosion resistance of tin plate. The history of this progress, the important factors affecting the steel and the devising of testing methods for predicting corrosion resistance have been told elsewhere (4). However, it may be said that the phosphorus and silicon content of tin-plate steels were found of particular importance, and the information about these and other technical points could be put to practical use in cold-reduced plate, then beginning to be introduced (5). Since other factors than composition are important to the performance of steel in most applications, it might be expected that more is involved with tin plate. Other unpublished work confirms this and indicates that certain of the details surrounding the process are not only quite critical but can in some cases nullify gains made through composition. In other words, where tin plate for corrosive applications is concerned, some sort of assurance should be obtained that proposed changes in manufacture will not produce serious, but subtle, changes in the product, noticed only when corrosion losses occur.

All of this information made it possible to furnish containers

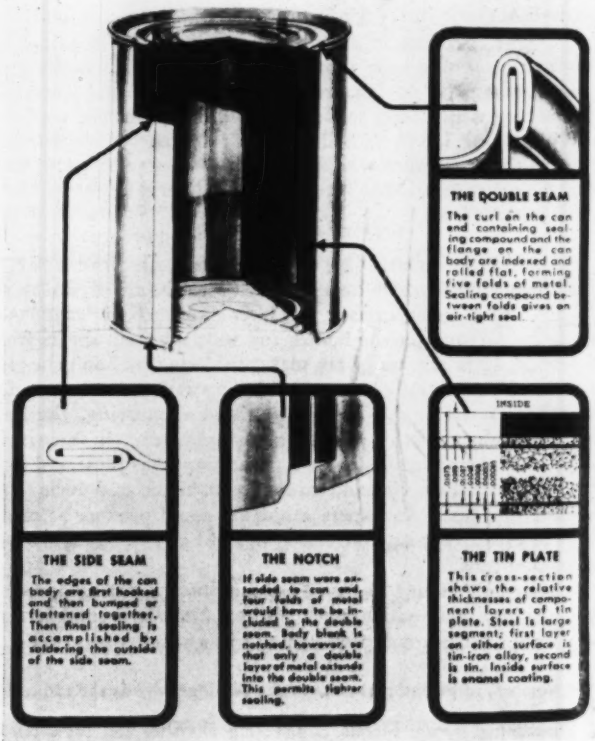

THE DOUBLE SEAM
The curl on the can end containing sealing compound and the flange on the can body are indexed and rolled flat, forming five folds of metal. Sealing compound between folds gives an air-tight seal.
THE SIDE SEAM
The edges of the can body are first hooked and then bumped or flattened together. Then final sealing is accomplished by soldering the outside of the side seam.
THE NOTCH
If side seam were extended to can end, four folds of metal would have to be included in the double seam. Body blank is notched, however, so that only a double layer of metal extends into the double seam. This permits tighter sealing.
INSIDE
THE TIN PLATE
This cross-section shows the relative thicknesses of component layers of tin plate. Steel is large segment; first layer on either surface is tin-iron alloy, second is tin. Inside surface is enamel coating.

FIG. 3 ARCHITECTURE OF THE ENAMELED SANITARY TIN CAN

with increased shelf life, substantial for all foods, but so marked for the more corrosive that losses are now rare in cases where trouble within 6 months was normal (6). Furthermore, the better steel also laid the foundation for the successful use of electrolytic plate during the war, thus making it possible to insure an adequate supply of food, and forthcoming improvements are expected to make the newer product more widely usable. Regardless of the technical information behind these improvements, it will be noted that more of the practical gains would not have been possible without the foresight of the tinplate producers who made the necessary and frequently very expensive changes in their equipment to permit the production of better tin plate.

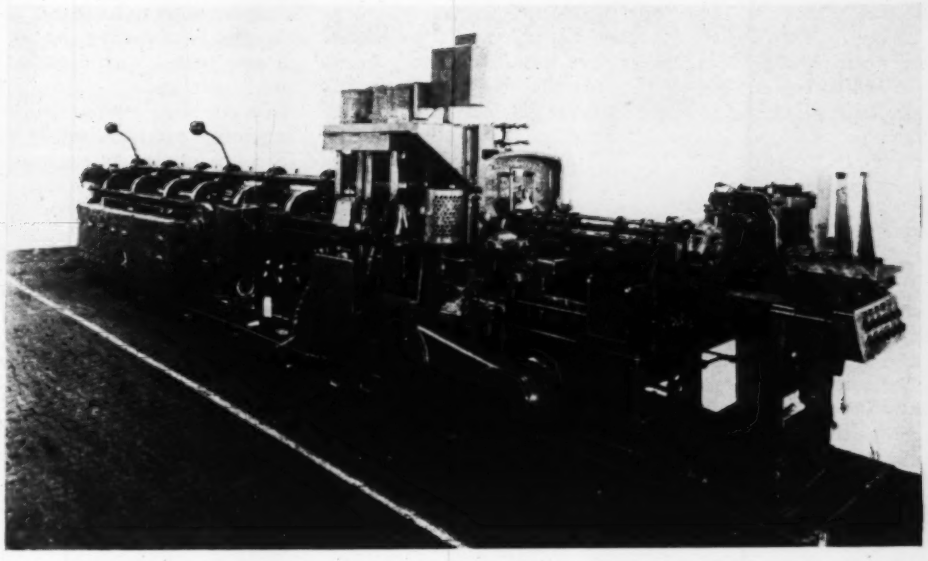


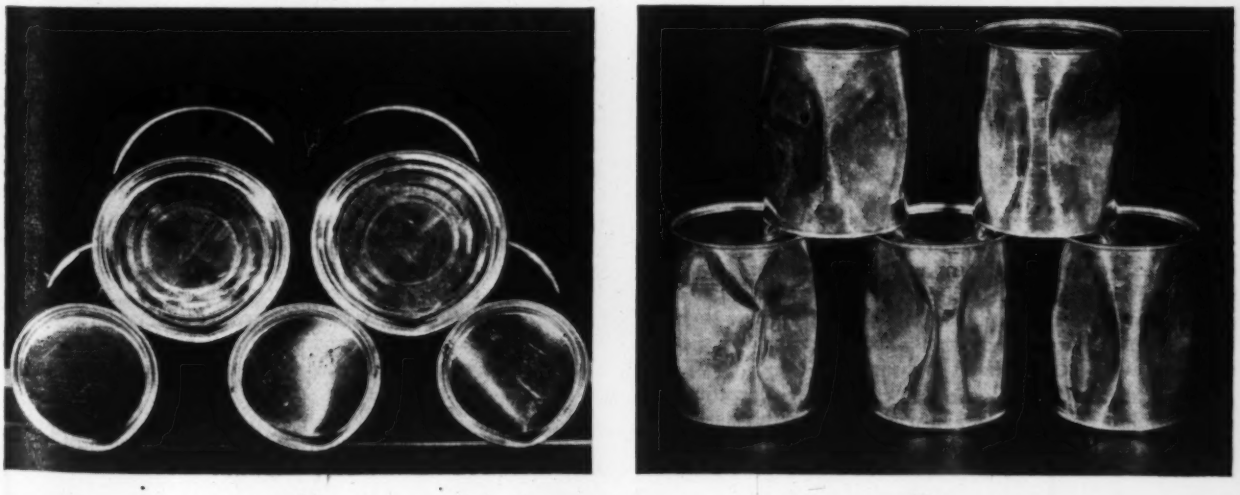
FIG. 4 MODERN CAN BODYMAKER

Certain low-acid food products, such as sweet corn, meats, and fish products, discolor the inside of the can, owing to the formation of spangles of tin sulphide. Successful canning of such products requires the use of enameled cans, and, for this purpose, tin plate is coated with an organic coating containing a small quantity of zinc-oxide pigment. Chemical films on the tin coating described by Kerr (7, 8), although effective in reducing sulphide discoloration with certain food products, have not attained significant commercial importance in this country.

The external corrosion or rust resistance of the can, although quite satisfactory under domestic conditions of canning and merchandising, becomes a major factor under adverse conditions of atmospheric storage, such as those imposed during the war when large quantities of food were shipped to the South Pacific. To prevent rusting, organic finishes were applied to the cans destined for overseas shipment either by use of outside-enameled cans or by coating the cans after heat-sterilizing in the canning plant. The latter method consisted of rolling the cans through a bath of suitable coating material followed by hot-air drying.

### STRENGTH FACTORS

Tin plate combines the corrosion-resistance properties of tin and the physical strength of steel, making possible a low-cost one-trip container. A container thrown away after use must be designed just strong enough to carry the product from the canner to the ultimate consumer, withstanding the abuse of handling and shipping. Cans for processed food products are subjected to conditions of temperature and pressure dependent upon the severity of heat processing required for sterility. Vegetables, meats, and fish may require pressure processes of 10- to 200-min duration at temperatures of 235 to 260 F depending upon the can size and pH of the product. During heating, a differential pressure builds up within the can over the retort



(*a*) (*b*)

FIG. 5 TYPE OF FAILURE

[(*a*) Cans buckled from internal pressure. (*b*) Cans paneled from internal vacuum.]

pressure as much as 20 psi for a product like cream-style corn. The can ends must therefore resist distortion at the countersink area, Fig. 5(*a*), as the retorts are opened and crates of cans removed to the cooling canals. On the other hand, tomato juice, fruit juices, and fruit products are given either a boiling-water process, a low-temperature process, or are filled into the can at a temperature of 190 to 205 F followed by water-cooling. This type of heat-treatment gives a vacuum within the can of 15 to 25 in. subjecting the can body to paneling or collapsing forces, Fig. 5(*b*).

The body of the can must be designed to withstand these forces as well as subsequent abuse during handling and shipping. Strength for these types of service is obtained by control of the tin-plate thickness, stiffness, and in addition for the larger cans, the placing of circumferential beads to reinforce the body. Furthermore, many special-purpose cans are designed specifically for the product such as beer, vacuum-packed coffee, and tennis balls. Each application presents special requirements to provide the most economical container.

Although the early cold-reduced tin plate provided improved corrosion resistance and deep-drawing qualities in comparison with the pack-rolled tin plate, it was too soft for can bodies and ends. The problem was to increase the buckling and paneling resistance without affecting its corrosion-resistant properties. Ultimately, the tin mills installed large tandem temper-rolling units to cold-work the surface of the plate and provide the desired stiffness.

Extensive research on cold-reduced tin plate showed that steel with a low metalloid content was not required for the mildly corrosive and noncorrosive food products. The results of these studies pointed the way to the attainment of desired stiffness by control of phosphorus content in the steel. Thus by temper-rolling and control of chemical composition, the properties of cold-reduced tin plate have been developed to meet the exacting requirements for food cans and special-purpose cans.

By converting the can requirements for ductility, paneling, and buckling resistance into physical properties of the sheet steel, a temper classification, consisting of six tempers was outlined from the softest plate practical for the tin mills to produce (T-1) to the stiffest plate practical for the can manufacturer to fabricate (T-6). Tin plates of T-1 and T-2 characteristics are used for drawn containers such as oval oil tops and drawn fish-can bodies. Tin plates of T-3 and T-4 characteristics are commonly used for the ends and bodies of processed-food cans. The T-5 plate is applied where higher resistance to buckling is required, such as in the large-diameter cans for items like peas, corn, and spinach, or where high resistance to paneling is required, such as in the bodies of vacuum-packed cans. T-6 is used only for flat-top beer-can ends.

*Organic Coatings.* As indicated previously, organic coatings for the inside of food cans have been developed over the years to meet certain specific requirements. These coatings, designated "can enamels," consist of baking varnishes made from natural or synthetic resins and drying oils. It was not until the development of the sanitary or open-top can that it became practical to produce an enameled can free from odor or taste. The early enameled cans were made by enameling the tin-plate sheets in the flat, cutting out the body blanks and scraping away the coating at the side seam to permit soldering.

Modern methods involve roller coating with cutout rolls which applies can enamel only where needed, leaving solder margins and lap areas free. The ovens are long tunnels, automatically heat-controlled by forced-air circulation and operate at a rate of 3600–6000 sheets of tin plate per hr. Can enamels which remain in contact with the food during processing for as long as 200 min at temperatures up to 260 F must possess adequate adhesion to the tin plate and not impart flavor or odor characteristics to food. A continuous check is maintained on the quality of coatings by packing representative food products in cans coated with each batch of enamel destined for use as inside coatings.

Certain food products such as the deeply colored fruits and vegetables are bleached by tin when packaged in plain cans. The development of the enameled can has made it possible to pack these products with only a slight loss of color. One of the early problems giving much concern to the food preserver using tin cans was the formation of "corn black" or iron sulphide. Residues of zinc-chloride flux in the hole-and-cap can was known to prevent formation of the corn black. Final solution to the problem came through addition of zinc oxide, suitably stabilized, to the organic coating.

Another class of food products noted for their detinning action on tin plate are packaged in enamel-lined cans. Such products are rhubarb, tomato-juice cocktail, and some fish products. In all the applications described, the prime purpose of the organic coating has been to preserve the natural quality and appearance of the food. In the years immediately prior to and during the war, organic coatings fulfilled an additional requirement, namely, that of extending the service life of both food and non-food containers, as the weight of tin coating was reduced through the use of substitute plates.

*Sealing Compounds.* Suitable materials for sealing the can end to the flanged body were essential factors in the development of the open-top sanitary can. The first can-sealing compound used by the Max Ams Company in 1895 consisted of a simple dispersion of rubber in benzol which was applied to the ends with a brush followed by dusting with asbestos powder. Machines were soon developed to apply the compound automatically. Modern machines extrude a solvent solution or water dispersion of rubber and suitable compounding ingredients into the narrow peripheral groove of the end, while the end spins on a chuck, and then discharge it to a drying station.

One of the most important requirements of a satisfactory sealing compound involves resiliency so that the compound will adjust itself to variations in seam tightness and fill all crevices and irregularities of the double seam. Furthermore, it must possess this resiliency over a temperature range from below room temperature to above 260 F, depending upon the product and heat-treatment involved.

The sealing compound must have adequate adherence to both plain tin plate and enameled tin plate, be impermeable to liquids and gases, and must not confer odor or taste or be affected by the product to be packed. When lined onto can ends and dried, the sealing compound must be relatively free from tackiness and possess adequate aging properties permitting the ends to be stored from one packing season until the next. Obviously, the compound, in addition to the foregoing requirements, must be of such viscosity stability, and consistency to give proper lining characteristics at high speeds. Extensive laboratory testing and commercial evaluation must be carried out in developing compounds for specific needs, such as vacuum holding qualities, process resistance, fat resistance, and solvent resistance.

Synthetic rubber was extensively substituted for natural rubber during the war with improvement in performance in many fields of application, and in particular for those where oil and solvent resistance is needed.

### MEETING THE NEED FOR TIN CONSERVATION

The development of the continuous cold-reduction of light-gage steel sheet was followed closely by continuous electrolytic deposition of the tin. The first pilot plants began operation in 1937. No further steps were taken, however, until 1942, when it became necessary to conserve the tin stocks of the United States.

In September, 1940, the first co-operative experimental program was undertaken to study the effect of reducing the tin-coating weight on hot-dipped tin plate. In December, 1941, the Technical Committee of the Can Manufacturers Institute formulated a tin-conservation program, involving the use of electrolytic tin plate and bonderized black plate. The plan called for an orderly retrenchment as the facilities for the production of these substitute plates became available. This plan, together with the results of extensive experimental packs made in 1942 and 1943, has been the subject of several papers by Messrs. Lueck (9), Brighton (10), Stewart and Pilcher (11), Cameron (12), Ball (13), Maier and Flugge (14), and others. The results of these investigations have shown that the planning was good. Only minor revisions in the thinking have been necessary during the intervening 6 years. Briefly, the research on substitutes for tin has pointed to the conclusion that the only substitue for tin is less tin.

To provide cans lower in tin, the War Production Board authorized in 1942 the construction of 25 electrolytic tinning lines with a rated annual capacity of 1,650,000 tons and 18 bonderizing lines with a rated annual capacity of 500,000 tons. This construction program was planned to take care of the major load in the event the length of the war demanded the elimination of hot-dipped tin plate altogether. The bonderizing lines came into production in midsummer, 1942. The first new electrolytic line began production early in 1943, and the last line was started in 1944. These new developments, which in normal times would have taken place over a 5- to 10-year period, came so fast that they encountered many growing pains involving problems in corrosion resistance, enamel adhesion, and soldering qualities. The electrolytic tin plates produced today are commercially satisfactory from the standpoint of enamel adhesion and soldering quality. Much investigational work remains to be done toward improving the corrosion resistance of electrolytic tin plate.

*Electrolytic Tin Plate.* The electrolytic tinning process permits a close control of the tin coating, promotes uniform distribution of tin, and is capable of producing tin-coating weights as light as 0.25 lb of tin per base box.[2] On this basis 1 lb of tin will coat 1740 sq ft of steel surface. The tin may be plated from either the alkaline stannate or acid baths. Of the 21 electrolytic lines currently operating on tin, 9 use the alkaline plating bath and 12 the acid bath.

The first electrolytic plate, produced in 1937, carried a tin-coating weight of 0.50 lb per base box and was used for the manufacture of cans and closures for dry products. The principal requirement was atmospheric rust resistance and, under the conditions of distribution in the domestic market, this weight of tin coating gave satisfactory performance. The need for conserving tin required an extension in the use of 0.50-lb electrolytic plate to processed food products such as peas, corn, succotash, spinach, and finally to fruit-can ends. For these applications, it has always been the practice to apply an inside enamel coating to the plate to provide adequate corrosion resistance. Only for dry products has electrolytic plate been applied without a can enamel.

An electrolytic plate carrying 0.75 lb of tin per base box was introduced in 1944 for sweetened condensed milk and was being seriously considered for evaporated milk when the war with Japan ended. It has since come into partial commercial use. A lighter tin-coating weight of 0.25 lb of tin per base box has recently come into use for the soldered parts of cans destined for dry food products, lubricating oils, paints, and many other nonfood applications. Many of the dry foods and nonfood cans are fully lithographed on the outside, confining the rust hazard to the inside of the can. This weight of tin coating has been found to be the lightest which will permit high-speed soldering of can parts without extensive equipment changes.

[2] A base box is an area of 217.78 sq ft (31,360 sq in.), or the equivalent area of 112 sheets, 14 in. × 20 in.

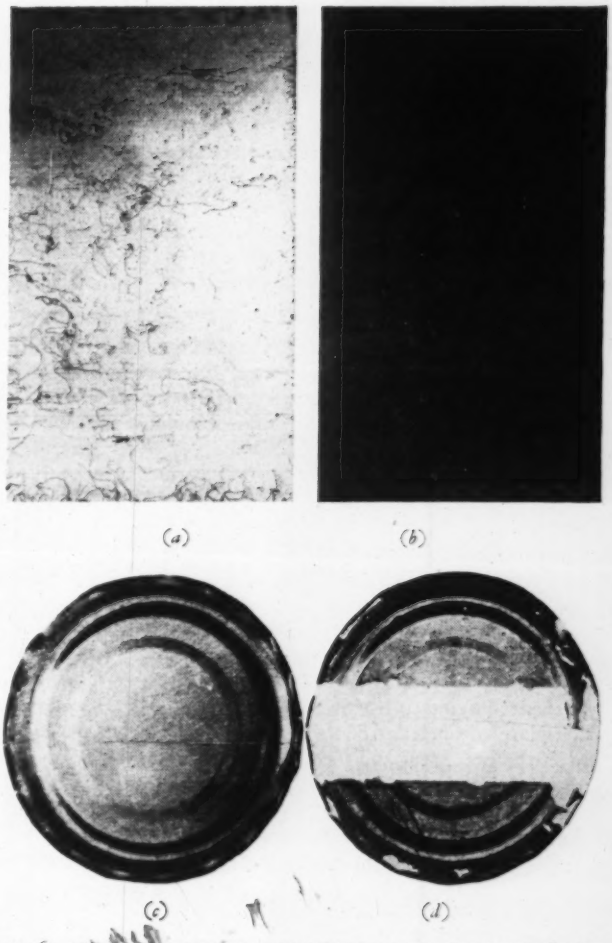


FIG. 6. SOME CHARACTERISTICS OF BLACK PLATE AND BONDERIZED PLATE

[(*a*) Coated black plate showing underfilm corrosion. (*b*) Coated bonderized plate. (*c*) Adhesion of coating to bonderized end on can packed with cream-style corn. (*d*) Lack of adhesion to black-plate end on can packed with cream-style corn.]

*Black Plate.* While steel or black-iron container parts have been manufactured for years, these parts have always been susceptible to atmospheric rusting and corrosion, manifested by the formation of an underfilm hairlike type of rust between the can enamel and the steel, Fig. 6(*a*). Steel sheets suitably oiled with a light film have exhibited sufficient rust resistance to permit shipment and limited storage in the northern part of the country where more favorable conditions of temperature and humidity prevail. Much difficulty has been experienced in the southern part of the country and some form of rust prevention has been found necessary.

During the war years, the bonderizing process was adapted to can uses as a rust preventative and base for can-enamel application. The treatment was applied by passing steel sheets through pressure sprays of the proprietary solution, forming a deposit of mixed crystals adhering tightly to the plate. The treated sheets possessed a measure of rust resistance permitting shipment and short storage of the uncoated plate, provided protection from underfilm corrosion, and promoted adhesion of can enamels during heat processing, Fig. 6(*b*). All three qualities were essential when black plate was used as a substitute for

TABLE 1 TIN-CONSERVATION STATISTICS

| | Tin-mill products, tons | Tin applied on tin-mill products, long tons | Tin applied on tin-mill products, lb per base box | Cumulative tin savings, long tons |
|---|---|---|---|---|
| 1940 | 3269966 | 40189 | 1.31 | |
| 1941 | 4351597 | 46650 | 1.14 | 6829 |
| 1942 | 3333633 | 29404 | 0.94 | 18396 |
| 1943 | 2690108 | 22643 | 0.90 | 28814 |
| 1944 | 3318621 | 26337 | 0.85 | 43263 |
| 1945 | 3670300 | 27395 | 0.80 | 60814 |
| 1946 | 3617202 | 27051 | 0.80 | 78076 |
| 1947[a] | 4330000 | 31800 | 0.79 | 99186 |

[a] Estimated.

tin plate. Owing to the difficulty of soldering bonderized plate, application was confined to end stock. Experimental packs of food products in cans with treated ends indicated that only those products with a pH of 5.5 or higher could be packaged on a commercial basis.

*Effective Tin Conservation.* During the period 1936 to 1940, inclusive, the tin-plate industry used 50 per cent of all the primary tin consumed in the United States. The tin used per ton of tin-mill products over this period is remarkably consistent at 27.5 lb per ton which is equivalent to 1.31 lb per base box. The first official action toward tin conservation in the manufacture of tin plate involved a reduction in the tin-coating weight on hot-dipped plate which was made in two steps; (*a*) a reduction from 1.50 lb to 1.35 lb per base box May 31, 1941; and (*b*) a further reduction to 1.25 lb on February 4, 1942. Bonderized black plate was first introduced in 1942 for can ends on 10 per cent of the corn, pea, and succotash packs.

Electrolytic plate came into further production on a 0.50-lb tin-coating basis in 1943, and its use has been extended each succeeding year. Electrolytic plate of 0.75 lb weight was first introduced for sweetened condensed milk and experimentally on evaporated milk in 1944; 0.25-lb electrolytic plate was first introduced for soldered parts of cans for nonaqueous products and for closures in 1946 and its use greatly extended in 1947.

It has been possible to estimate the over-all tin saving during the war years through the use of data obtained from the production records for tin-mill products and the total tin consumed, Table 1. Beginning in 1940, with a tin consumption of 1.31 lb per base box, the amount has been decreased gradually to 0.80 lb per base box in 1945. Through these data, it has been possible to calculate the effective tin conservation for tin-mill products during the war years. It is shown as a cumulative figure which, by the end of 1947, has built up to over 99,000 long tons. Had not this conservation program been carried out, the national stock pile of pig tin would have been inadequate for the emergency.

*Tin in Solder.* It is estimated that during the years 1940 and 1941, the can-manufacturing industry consumed 4500 and 6000 tons of tin, respectively, for the production of solder containing 40 per cent tin and 60 per cent lead. Investigations with tin-lead solder compositions, containing progressively less tin from 40 per cent to 20 per cent, showed a decreasing side-seam strength with lower tin contents. On the other hand, experiments carried on with a $2^1/_2$ per cent silver, $97^1/_2$ per cent lead solder showed a marked improvement in the side-seam strength in comparison with 40/60 tin-lead solder. Special manufacturing techniques were developed to apply this tinless solder, which involved the use of preheaters, after-heaters, and higher soldering temperatures, together with more acid-type fluxes. It was found that,during operation of a can line on silver-lead solder, the tin content of the solder bath built up to approximately 5 per cent, with only a slight reduction in the can strength. It was later found that the silver could be omitted without detracting from can performance, leading to the adoption of 5/95 solder for all applications except inside soldered seams. Through the use of low-tin solders, it was possible to reduce the annual tin consumption from 6000 to less than 3500 long tons or an accumulated saving of over 10,000 long tons.

Cans soldered with low-tin solder exhibit the characteristic dark discoloration of lead and are slightly less rust resistant along the side seam; however, for ordinary domestic distribution of canned foods, it is believed that the low-tin solder will continue to give adequate performance, and that a large portion of the tin saving will become permanent.

SUMMARY

A brief outline has been given of the operations in making metal cans and of the requirements of raw materials which contribute to their usefulness as a single-trip package. The tinplate must have adequate corrosion resistance and strength, and be coated with can enamels for some food and nonfood products when sulphide staining occurs, or when the color of the food is to be preserved. Can enamels should be free from taste and odor and exhibit adherence to tin plate during heat-processing. Sealing compounds must provide sealing efficiency over a wide range of temperatures and not affect or be affected by the products packed with respect to taste, odor, or sealing qualities.

Years of research on metal cans gave the industry the necessary "know-how" when it became necessary to conserve the nation's stocks of tin. It is estimated that together with other tin-plate-consuming industries, an effective tin saving of 99,000 long tons was accomplished through 1947, and in addition, the can industry accomplished a saving of 10,000 long tons through the use of low-tin solders.

ACKNOWLEDGMENT

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# PROGRESS *in* RAILWAY MECHANICAL ENGINEERING[1]

# 1946-1947

DURING the past year the installation of Diesel-electric locomotives has continued at an accelerated pace, especially in the United States. Expansion in the use of this type of motive power for main-line service has been limited only by the manufacturers' ability to make shipments. In addition, there has been considerable activity evident in the dieselization of branch lines, a trend which has resulted in the introduction of many new locomotives designed for the flexibility required in that type of operation.

Extensive shipments of Diesel-electric locomotives to South America and, to some extent, Europe indicate the broadening efforts of foreign railroads to gain the improved service and efficient operation that have been experienced by many American railroads. Indicative of changing trends caused by the severity of the world fuel situation is the fact that two railways in Great Britain have placed orders for Diesel-electric road locomotives for main-line service.

Increased efforts are being made to obtain the maximum utilization of Diesel-electric motive power—efforts which have provided valuable lessons serving to make more efficient use of existing steam power. Improved maintenance and repair programs, longer runs, and increased availability are objectives toward which marked improvements have been made. Records of 29,000 miles per month per locomotive, established by several American steam locomotives during the year, indicate that technological improvements in steam locomotives coupled with better handling, servicing, and scheduling by the railroads have made significant strides.

Increased activity in the field of electrification is evidenced in many nations, particularly in foreign countries, as the need of greater operating economies and the problems of basic fuel procurement become more pressing.

The coal-burning steam turbine-electric locomotives, recently placed in service in the United States, represent an interesting development in the year's activities. In addition, the gas turbine-electric locomotive holds the increasing interest of railroad officials throughout the world. At the present time, no less than 12 gas turbine-electric locomotives are being designed in the United States, Great Britain, Switzerland, and France.

The foregoing developments are discussed elsewhere in this report.

As mentioned in the 1945-1946 report of this Committee, the pressing financial condition of the railroads and the record-breaking peacetime levels of traffic are problems which have served to bring about increased consciousness on the part of operating officials toward locomotive economics. Motive power discussed in this report is indicative of efforts, both in America and abroad, being made to meet such problems.

[1] Report of Committee RR-6, Survey; chairman, T. F. Perkinson; members, E. R. Battley, F. Benger, R. P. Johnson, F. L. Murphy, H. C. Wilcox.

Contributed by the Railroad Division and presented at the Annual Meeting, Atlantic City, N. J., Dec. 1–5, 1947, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

## DOMESTIC STEAM LOCOMOTIVES

Item 1, Table 1, and Fig. 1 describe a 4-6-2 locomotive rebuilt during the year in the shops of the Nashville, Chattanooga & St. Louis Railway. Although no changes were made in the boiler design, the running gear and tender are completely new. New frames with wide pedestal jaws to accommodate the bearing boxes were forged in the railway's shops.

The four locomotives and the cars for the Baltimore and Ohio Railroad's new "Cincinnatian" trains were built completely at the railroad's Mount Clare shops. One of these streamlined Pacific locomotives, description of which is given in item 2, Table 1, is shown in Fig. 2.

Item 3, Table 1, describes five streamlined passenger locomotives for the Chesapeake and Ohio Railway which were rebuilt in the company's Huntington shops. Illustrated in Fig. 3, the original locomotives had a 4-6-2 wheel arrangement. Rebuilt into a 4-6-4, only the tender and a part of the boiler were used in its reconstruction. The locomotive, sheathed in stainless steel, embodies a new firebox and smokebox, roller-bearing driving wheels, roller-bearing rods and a high-speed booster. The principal departure from the old mechanical design is the use of poppet valves.

An experimental coal-burning switching locomotive has been rebuilt from an old 4-8-0 locomotive by the Norfolk and Western Railway in co-operation with the Standard Stoker Company. Item 4, Table 1, gives the details of the new locomotive which is pictured in Fig. 4. New features include mechanical lubrication, induced draft, and automatic controls on the fan, stoker, dampers, and stand-by water feed pump. These features, with increased tender capacity, will increase greatly the availability of the locomotive. It is also expected that the new equipment will secure faster steaming and more complete combustion, thereby creating an appreciable reduction in the emission of smoke.

## FOREIGN STEAM LOCOMOTIVES

The locomotive described in item 1, Table 2, is the first of a new class completed by the London Midland and Scottish Railway Company during the year. The locomotive, illustrated in Fig. 5, was designed with very low axle weights and built especially for branch-line service, the latter being a practice which has not been general in the past.

Item 2 of Table 2 describes new locomotives being delivered by British builders to the Central Railway and Southern Railway of Peru. One of these oil-burning locomotives is shown in Fig. 6. The rugged conditions under which these locomotives will operate are indicated by the fact that the main line of the Central of Peru rises from sea level to 15,805 ft and includes 74 miles of continuous 4 per cent grade.

The North British Locomotive Company has completed 110 locomotives of the 2-8-2 type for India. A locomotive of this class is described in item 3, Table 2, and is illustrated in Fig. 7.

Forty new locomotives which have been delivered to the Malayan Railway by the North British Locomotive Company

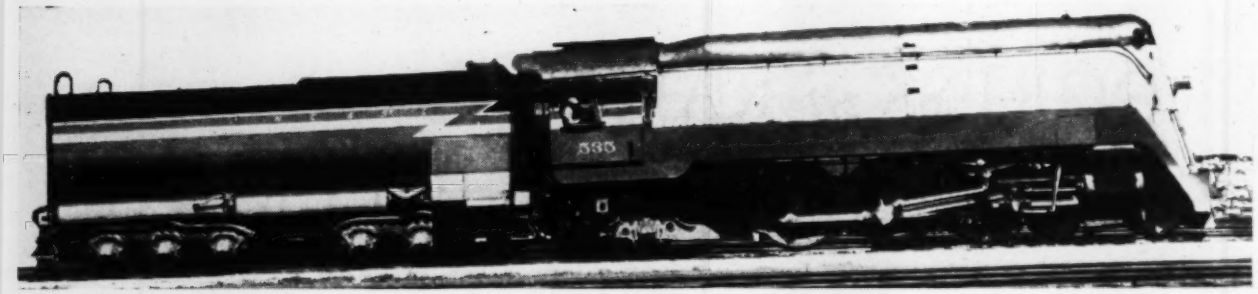

FIG. 1 STREAMLINED PACIFIC LOCOMOTIVE FOR THE NASHVILLE, CHATTANOOGA & ST. LOUIS RAILWAY

FIG. 2 STREAMLINED PACIFIC LOCOMOTIVE FOR THE BALTIMORE AND OHIO RAILROAD

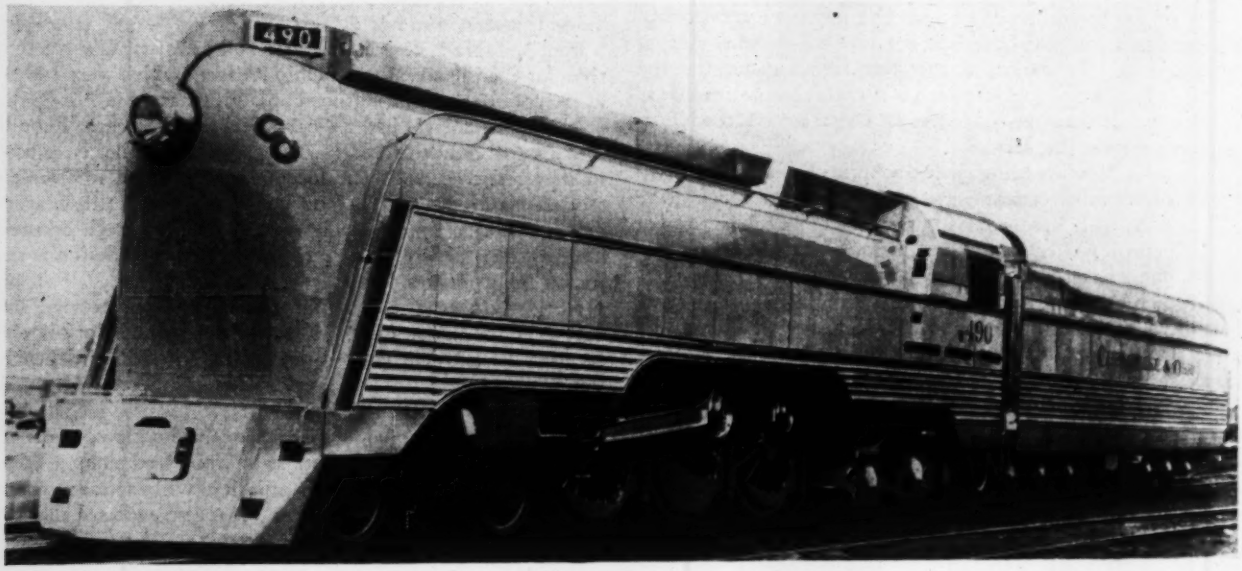


FIG. 3 4-6-4 PASSENGER LOCOMOTIVE FOR THE CHESAPEAKE & OHIO RAILWAY

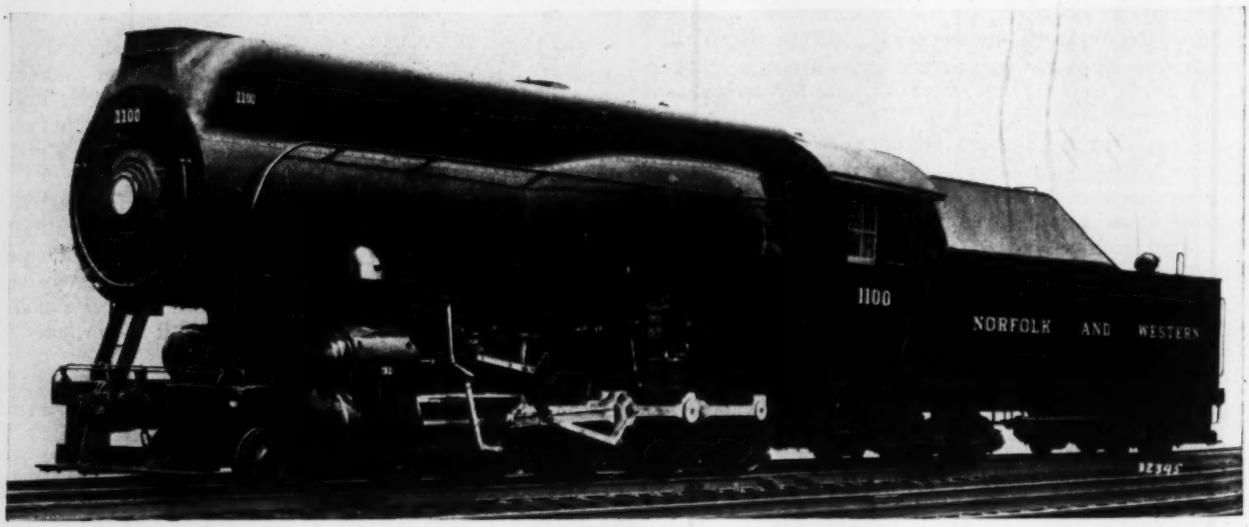


FIG. 4 MODERNIZED NORFOLK AND WESTERN SWITCHING LOCOMOTIVE

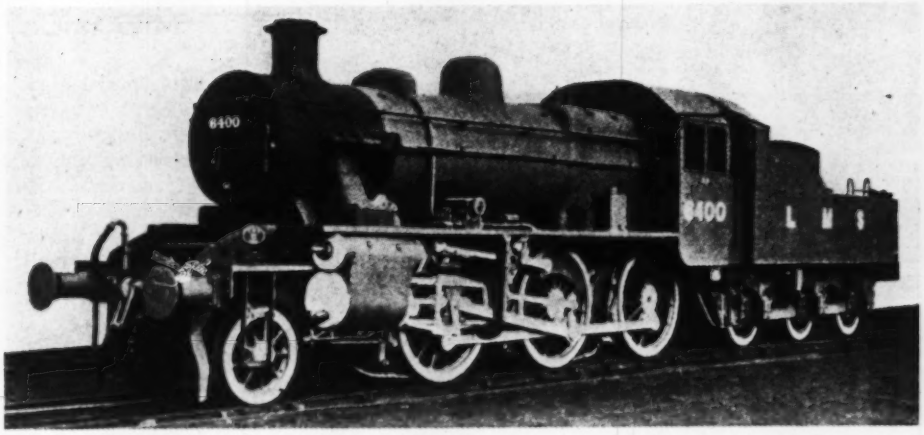


FIG. 5 BRANCH-LINE UNIT FOR THE LONDON MIDLAND AND SCOTTISH RAILWAY

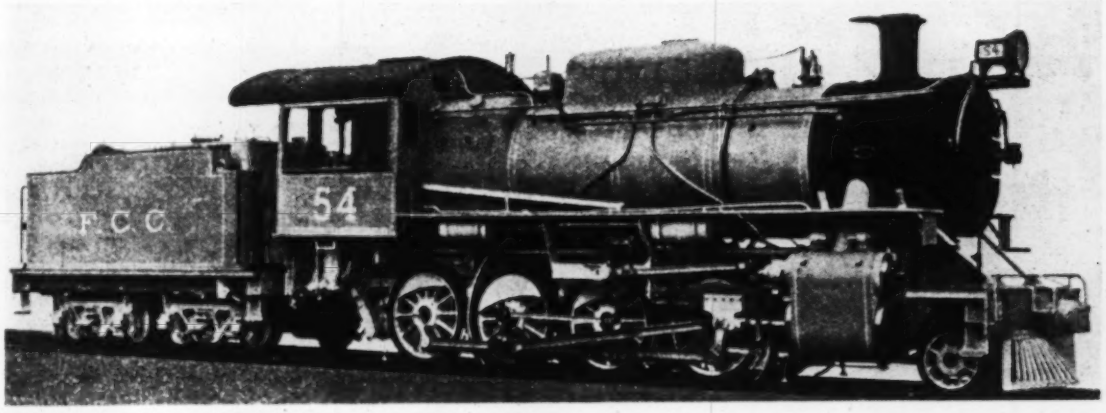


FIG. 6 AN OIL-BURNING LOCOMOTIVE FOR SERVICE IN PERU

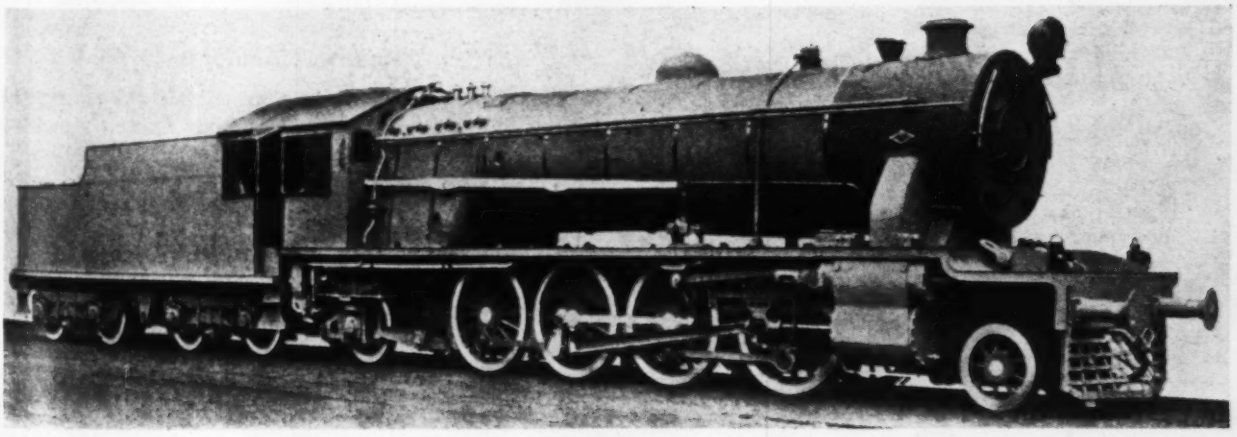

FIG. 7 BRITISH-BUILT LOCOMOTIVE FOR INDIA

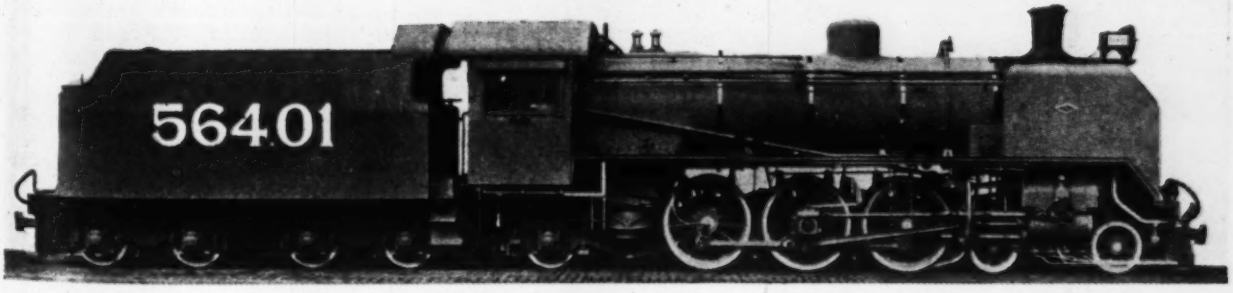


FIG. 8 MALAYAN LOCOMOTIVE BUILT IN GREAT BRITAIN

TABLE 1 STEAM LOCOMOTIVES FOR SERVICE IN THE UNITED STATES

| Item | Builder | Owner | Wheel arrangement | Service | Cylinders No. | Cylinders Diam | Cylinders Stroke | Boiler Pressure | Driver diam | Weight on drivers | Total weight locomotive running order | Heating surfaces Evaporative | Heating surfaces Superheater | Heating surfaces Total | Grate area | Track gage | Tender data Wheels | Tender data Fuel, tons | Tender data Water | Weight ⅔ loaded |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | N C & St L | N C & St L | 4–6–2 | P | 2 | 25 | 28 | 200 | 72 | 170000 | 265800 | 3881 | 810 | 4691 | 66 | 56½ | 12 | 16 | 15000 | 242800 |
| 2 | B & O | B & O | 4–6–2 | P | 2 | 27 | 28 | 230 | 80 | 211000 | 347500 | 3843 | 950 | 4793 | 70 | 56½ | 12 | 25 | 20000 | 275000 |
| 3[a] | C & O | C & O | 4–6–4 | P | 2 | 27 | 28 | 210 | 74 | 202900 | 388700 | 4414 | 2001 | 6415 | 81 | 56½ | 12 | 28 | 18000 | 286600 |
| 4 | N & W | N & W | 4–8–0 | Sw | 2 | 24 | 30 | 200 | 56 | 239500 | 279500 | 3215 | .. | 3215 | 45 | 56½ | 8 | 20 | 11000 | 138000 |

TABLE 2 STEAM LOCOMOTIVE FOR FOREIGN SERVICE

| Item | Builder | Owner | Wheel arrangement | Service | Cylinders No. | Cylinders Diam | Cylinders Stroke | Boiler Pressure | Driver diam | Weight on drivers | Total weight locomotive running order | Heating surfaces Evaporative | Heating surfaces Superheater | Heating surfaces Total | Grate area | Track gage | Tender data Wheels | Tender data Fuel, tons | Tender data Water | Weight ⅔ loaded |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | British | LMS | 2–6–0 | P-F | 2 | 16 | 24 | 200 | 60 | 85400 | 103600 | 1025 | 134 | 1159 | 17.5 | 56½ | 6 | 4 | 3000 | 70000 |
| 2 | British | Peru | 2–8–0 | F | 2 | 20½ | 28 | 200 | 56 | 150500 | 170200 | 1717 | 341 | 2058 | 28 | 56½ | 6 | 1465[c] | 2650 | 112000 |
| 3 | British | India | 2–8–2 | P-F | 2 | 22½ | 28 | 180 | 61½ | 152400 | 220200 | 2145 | 540 | 2685 | 45 | 66 | 8 | 14.5 | 4500 | 125775 |
| 4[a] | British | Malay | 4–6–2 | F | 3 | 13 | 24 | 250 | 54 | 84150 | 130800 | 1109 | 218 | 1327 | 27 | 39¾ | 8 | 11 | 3430 | 79900 |
| 5 | New Zealand | New Zealand | 4–8–2 | P-F | 2 | 18 | 26 | 200 | 54 | 100200 | 154500 | 1469 | 283 | 1752 | 39 | 42 | 8 | 5.5 | 4100 | 71900 |
| 6 | Czechoslovakia | Czechoslovakia | 4–8–2 | P | 3 | 19½ | 27 | 230 | 72½/16 | 159400 | 234000 | 2765 | 795 | 3570 | 51 | 56½ | 8 | 10 | 7700 | 121800 |
| 7 | Sweden | Netherlands | 0–8–0 | F | 3 | 11¾ | 26 | 184 | 53¼ | 162400 | 162400 | .. | .. | 1600 | 32 | 56½ | 8 | 7.7 | 5950 | 95000 |
| 8 | Sweden | Netherlands | 4–6–0 | P | 3 | 11¾ | 26 | 170 | 74½ | 121000 | 183300 | .. | .. | 1744 | 34 | 56½ | 8 | 7.7 | 5950 | 95000 |
| 9 | Sweden | Sweden | 4–8–0 | F | 3 | 17¾ | 24 | 199 | 55¼ | 112800 | 163000 | .. | .. | 1480 | 30 | 56½ | 6 | 7.7 | 4360 | 74250 |
| 10 | France | France | 4–8–4 | P | 3 | (see note[b]) | | 285 | 76 | 182000 | 321000 | 2722 | 1291 | 4013 | 54 | 56½ | 8 | .. | ... | .... |

[a] Poppet-valve application.

[b] Low-pressure (2) 26¾ in. × 29¹⁵/₁₆ in.; high-pressure (1) 23⁵/₈ in. × 28⁵/₁₆ in.

[c] Gallons.

NOTES FOR TABLES 1 AND 2:

P = Passenger. F = Freight
Fuel in tons (2000 lb). Water in U. S. gallons.
Boiler pressure expressed in pounds per square inch.
Weights expressed in pounds.
Heating surfaces and grate areas expressed in square feet.
Wheel diameters, gage and cylinder dimensions expressed in inches.
N C & St L = Nashville, Chattanooga & St. Louis Railway.
B & O = Baltimore and Ohio Railroad.
C & O = Chesapeake and Ohio Railway.
N & W = Norfolk and Western Railway.
B L W = Baldwin Locomotive Works.
L M S = London, Midland and Scottish Railway.

are described in item 4, Table 2, and illustrated in Fig. 8. A notable feature of design is the use of three high-pressure cylinders and rotary-cam poppet valves.

Item 5, Table 2, lists the specifications of 35 new 4-8-2 locomotives being built by the New Zealand Railways in their own shops. Roller bearings have been applied to all axles on each locomotive and tender with outside bearings being used on the engine truck. Roller bearings have been applied to the crankpins on the first locomotive in order to determine the feasibility of similar installations on later locomotives of this class (Fig. 9).

The Skoda Works at Pilsen are again manufacturing locomotives after the rebuilding of its shops damaged during the war. The Czechoslovak State Railways have received 40 locomotives, one of which is described in item 6, Table 2. Illustrated in Fig. 10, this three-cylinder passenger locomotive features an all-welded boiler and firebox, and is equipped throughout with roller bearings.

Materially aiding in the reconstruction of the Netherlands State Railways, Nydqvist and Holm of Sweden are delivering to the Netherlands two new classes of steam locomotives. The first of these, described in item 7, Table 2, and illustrated in Fig. 11, is a three-cylinder freight locomotive with an 0-8-0 wheel arrangement. The second, shown in Fig. 12, is a passenger locomotive similarly having three-cylinder drive. The specifications of the latter are given in item 8, Table 2.

The same builder is supplying to the Swedish State Railways a series of passenger locomotives employing a 4-8-0 wheel arrangement and a three-cylinder design. Described in item 9, Table 2, one of these locomotives is shown in Fig. 13.

Fig. 14 illustrates a 4-8-4 locomotive rebuilt for the French National Railways. Three-cylinder drive was retained from the original Mountain-type locomotive built in 1932, and converted into a compound locomotive during the year in order to gain improved efficiency in the handling of high-speed passenger trains (Item 10, Table 2).

### ELECTRIC LOCOMOTIVES

During the year, the Great Northern Railway received two streamlined motor-generator locomotives for heavy mountain service in the northwestern part of the United States. The locomotives, being the largest single-cab units ever built, are described in item 1, Table 3, and are illustrated in Fig. 15. Having 735,000 lb on drivers and 5000 rail horsepower (rhp) continuously available for traction, each locomotive has a corresponding tractive effort of 119,000 lb. Rated on the basis of input to the traction generator for traction purposes, as is customarily done with Diesel-electric locomotives, the rating is 6000 hp per cab. They may be operated in multiple with similar units.

Item 2, Table 3, gives the salient characteristics of the first of a series of 26 lightweight high-speed electric locomotives for service on the Swiss Federal Railways. The locomotives, classified as "Re 4/4," are being constructed by various Swiss builders (Fig. 16).

The Central Railway of Brazil has recently placed in service a new class of electric locomotives which were built in its own shops, utilizing electrical equipment purchased in the United States. Fig. 17 illustrates one of these locomotives, and a description is given in item 3, Table 3.

Fig. 18 illustrates the first of an order for electric locomotives for switching service on the Paulista Railway of Brazil. Important characteristics of these locomotives are given in item 4, Table 3.

An interesting group of seven two-power locomotives has been delivered to the Phelps-Dodge Corporation by Baldwin-Westinghouse. Described in item 5, Table 3, and illustrated

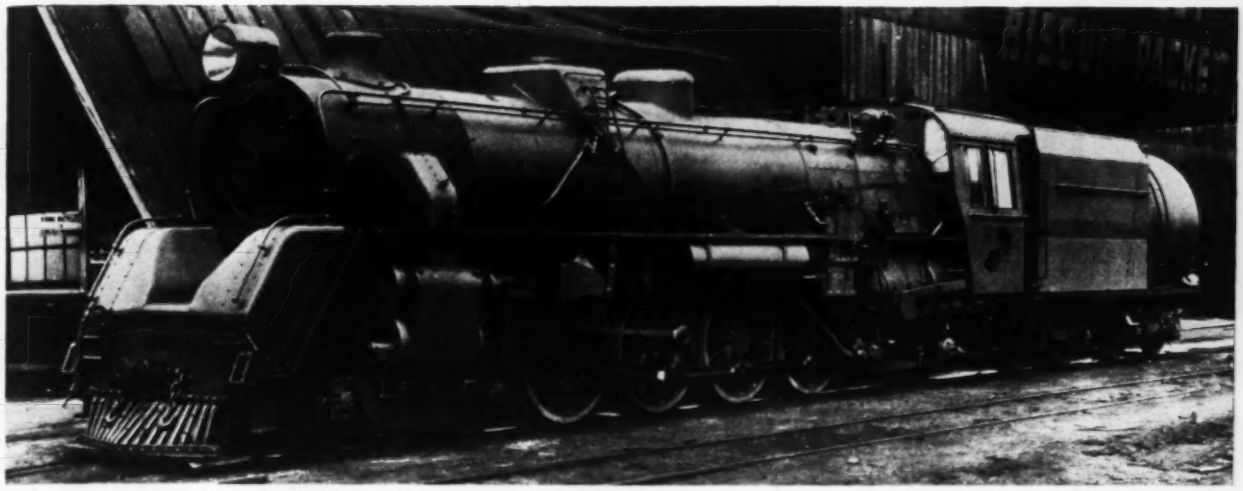

FIG. 9 4-8-2 LOCOMOTIVE FOR NEW ZEALAND

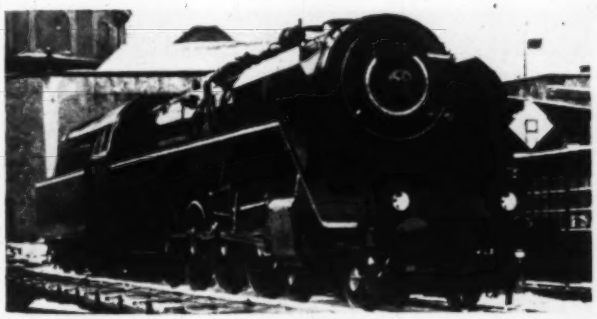

FIG. 10 LOCOMOTIVE FOR CZECHOSLOVAK STATE RAILWAYS

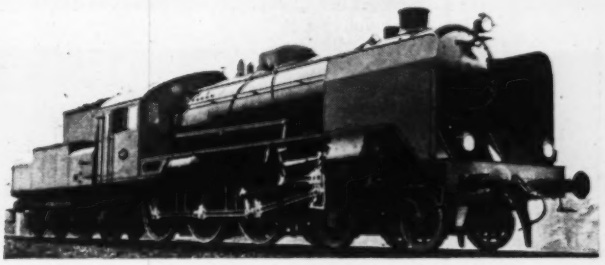

FIG. 12 PASSENGER LOCOMOTIVE FOR THE NETHERLANDS

FIG. 11 SWEDISH-BUILT LOCOMOTIVE FOR THE NETHERLANDS

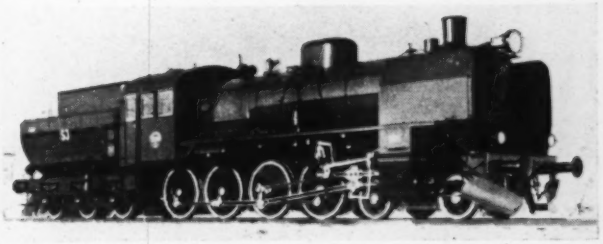

FIG. 13 POSTWAR LOCOMOTIVE FOR SWEDISH STATE RAILWAYS

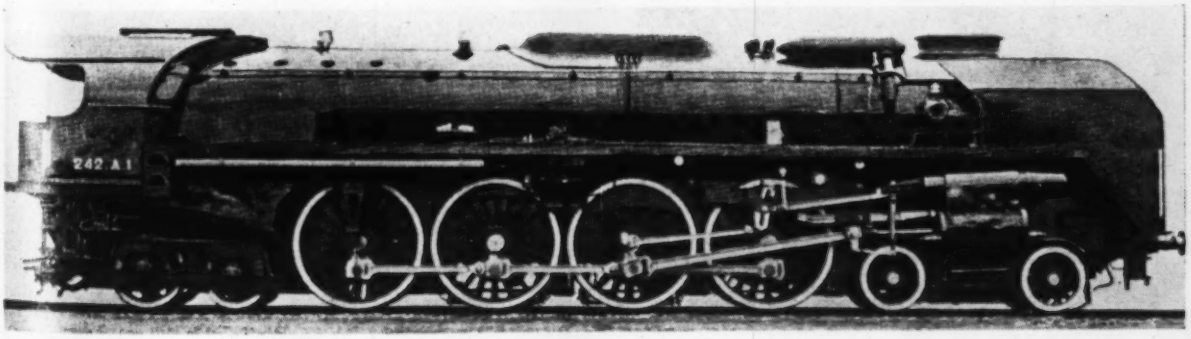


FIG. 14 THREE-CYLINDER PASSENGER LOCOMOTIVE FOR FRANCE

TABLE 3 CHARACTERISTICS OF ELECTRIC LOCOMOTIVES

| | Item 1 | Item 2 | Item 3 | Item 4 | Item 5 |
|---|---|---|---|---|---|
| Railroad | GN[a] | Swiss | Central[d] | Paulista[e] | Phelps-Dodge |
| Builder, mechanical | GE[b] | (see note [c]) | Central[d] | GE | BLW[f] |
| Builder, electrical | GE | (see note [c]) | GE | GE | WEC[h] |
| Wheel arrangement | B−D+D−B | B−B | B−B | B−B | B+B |
| Service (pass., freight, switching) | P-F | P | P-F | Sw | Sw |
| Power supply | 11000 v, a-c | 15000 v, a-c | 3000 v, d-c | 3000 v, d-c | ([g]) |
| Current collector | Pantograph | Pantograph | Pantograph | Pantograph | Pantograph |
| Driving wheels: | | | | | |
| Number | 24 | 8 | 8 | 8 | 8 |
| Diameter, in. | 42 | 41 | 42 | 40 | 40 |
| Weight, lb: | | | | | |
| Total | 735000 | 124300 | 116400 | 125000 | 242000 |
| On drivers | 735000 | 124300 | 116400 | 125000 | 242000 |
| Per driving axle | 61250 | 31100 | 29100 | 31250 | 60500 |
| Dimensions: | | | | | |
| Length over-all, ft-in. | 101-0 | 48-2 1/2 | 44-10 | 41-6 | 47-4 |
| Width over-all, ft-in. | 11-3/16 | 9-8 | 9-5 | 10-0 | 10-3 |
| Height, pantograph down, ft-in. | 16-0 | 14-9 | 13-3 | 13-3 | 16-10 |
| Rigid wheel base, ft-in. | 16-9 | 9-10 | 8-5 | 8-0 | 9-6 |
| Total wheel base, ft-in. | 85-9 | 35-5 | 29-11 | 30-4 | 29-6 |
| Traction motors: | | | | | |
| Number | 12 | 4 | 4 | 4 | 4 |
| Method of mounting | Axle susp. | Truck frame | Axle susp. | Axle susp. | Axle susp. |
| Method of drive | Single gear | Quill spr. gr. | Single gear | Single gear | Single gear |
| Gear ratio | 70/17 | 2.85/1 | 70/17 | 64/17 | 59/16 |
| Tractive force, lb: | | | | | |
| One-hour rating | ... | 17720 | 15300 | 23600 | ... |
| Per cent adhesion | ... | 14.25 | 13.14 | 17.27 | ... |
| Continuous rating | 119000 | 14460 | 12970 | 13900 | 33000 |
| Per cent adhesion | 16.18 | 11.63 | 11.13 | 11.12 | 13.50 |
| Horsepower: | | | | | |
| One-hour rating | ... | 2420 | 1120 | 600 | ... |
| Continuous rating | 5000 | 2180 | 990 | 430 | 1360 |
| Speed, mph: | | | | | |
| One-hour rating | ... | 51.3 | 27.5 | 10.3 | ... |
| Continuous rating | 15.8 | 56.6 | 28.7 | 11.6 | 15.2 |
| Maximum speed, mph | 65 | 78 | 64 | 37 | 40 |
| Equipped for: | | | | | |
| Regeneration | Yes | Yes | No | No | No |
| Multiple-unit operation | Yes | Yes | Yes | No | No |
| Track gage, in. | 56 1/2 | 56 1/2 | 63 | 63 | 56 1/2 |

NOTES FOR TABLE 3:
[a] Great Northern Railway.
[b] General Electric Company.
[c] Brown Boveri, Oerliken, Secheron.
[d] Central Railway of Brazil.
[e] Paulista Railway of Brazil.
[f] Baldwin Locomotive Works.
[g] 1700 v, d-c and two 325-hp Diesel engines (Sterling).
[h] Westinghouse Electric Corp.

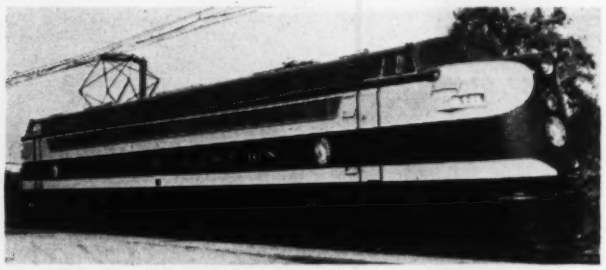

FIG. 15 A 5000-HP MOTOR-GENERATOR LOCOMOTIVE FOR THE GREAT NORTHERN

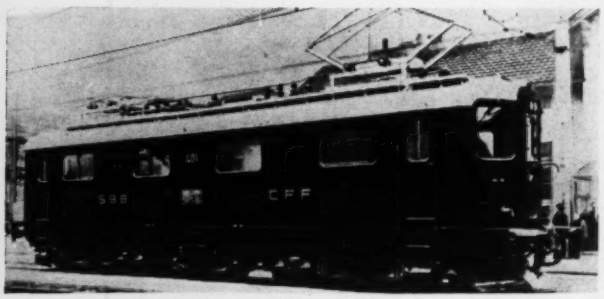

FIG. 16 LIGHTWEIGHT PASSENGER LOCOMOTIVE FOR SWITZERLAND

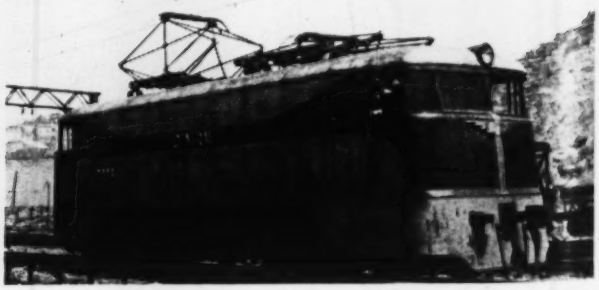

FIG. 17 3000-VOLT, D-C LOCOMOTIVE FOR BRAZIL

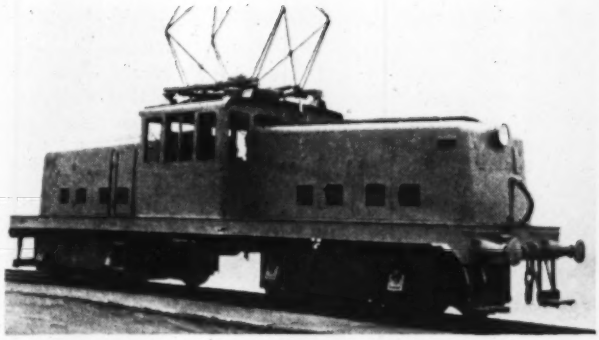

FIG. 18 3000-VOLT, D-C SWITCHING LOCOMOTIVE FOR PAULISTA RAILWAYS

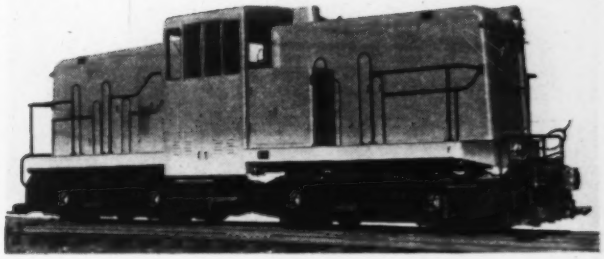

FIG. 20 47-TON UNIT FOR SOROCABANA

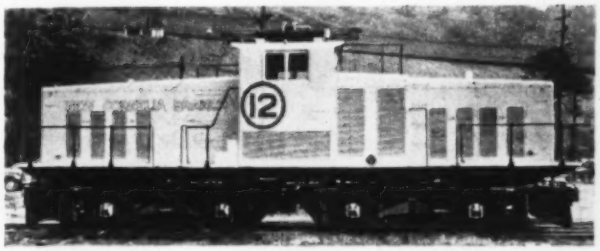


FIG. 19 TWO-POWER MINING LOCOMOTIVE

FIG. 21 C + C DIESEL-ELECTRIC FOR SOROCABANA

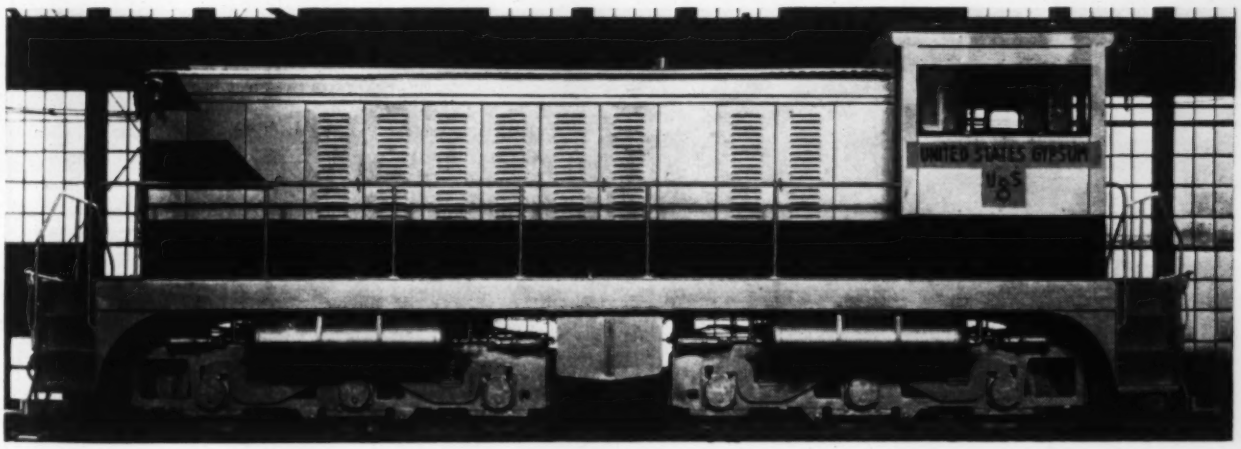


FIG. 22 LIGHTWEIGHT NARROW-GAGE SWITCHER

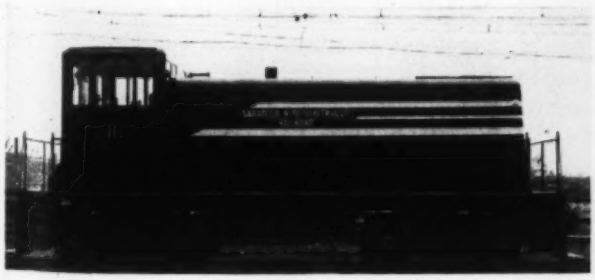

FIG. 23 70-TON BRANCH-LINE UNIT

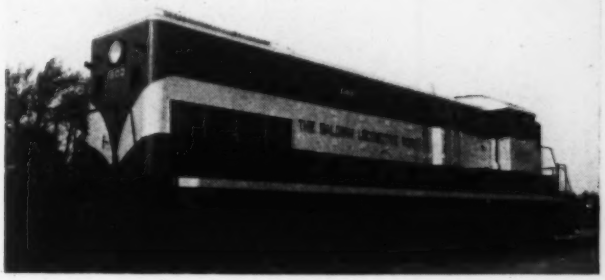

FIG. 24 MIXED-SERVICE LOCOMOTIVE FOR COLUMBUS & GREENVILLE RAILWAY

TABLE 4 CHARACTERISTICS OF DIESEL-ELECTRIC LOCOMOTIVES

| | Item 1 | Item 2 | Item 3 | Item 4 | Item 5 | Item 6 | Item 7 | Item 8 | Item 9 | Item 10 | Item 11 | Item 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Builder | GE[b] | GE | H. K. Porter | Alco-GE[g] | BLW[h] | BLW | Alco-GE | Alco-GE | F-M[j] | F-M | BLW | EMD[n] |
| Owner | Soro[c] | Soro | U.S. Gypsum | Various R.R. | C & G[i] | | Various R.R. | Various R.R. | Various R.R. | Various R.R. | CRRNJ[m] | Various R.R. |
| Wheel arrangement (per unit) | B + B | C + C | C − C | B − B | A1A − A1A | A1A − A1A | B − B | A1A − A1A | B − B | B − B | A1A − A1A | B − B |
| Number of units | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 4 |
| Service (see note [a]) | F, Sw | F | Sw | P, F, Rd Sw | F, Rd Sw | P | Rd Sw | Rd Sw | P, F, Rd Sw | F, Rd Sw | P | P, F |
| Engine data: | | | | | | | | | | | | |
| No. of engines (total) | 2 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 2 | 4 |
| Total hp rating | 330 | 600 | 600 | 600 | 1500 | 1500 | 1500 | 1500 | 1500 | 2000 | 2000 | 6000 |
| No. of cylinders (per engine) | 8[d] | 6 | 6 | 6 | 8 | 8 | 12[d] | 12[d] | 8[k] | 10[k] | 8 | 16[d] |
| Bore and stroke, in. | 5¾ × 8 | 9 × 10½ | 9 × 10½ | 9 × 10½ | 12¾ × 15½ | 12¾ × 15½ | 9 × 10½ | 9 × 10½ | 8½ × 10 | 8½ × 10 | 12¾ × 15½ | 8½ × 10 |
| Speed, rpm | 1000 | 1000 | 1000 | 1000 | 625 | 625 | 1000 | 1000 | 835 | 850 | 625 | 800 |
| Cycles | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 4 | 2 | 2 | 4 | 2 |
| Supercharged | No | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | Yes | No |
| Manufacturer | Cat[e] | C-B[f] | C-B | C-B | BLW | BLW | Alco | Alco | F-M | F M | BLW | EMD |
| Length over-all, ft-in. | 35-11½ | 38-2 | 43-6 | 37-0 | 58-0 | 58-0 | 55-5¾ | 55-5¾ | 54-0 | 51-0 | 80-0 | 201-4 |
| Rigid wheel base, ft-in. | 7-6 | 5-0 | 10-0 | 6-10 | 11-6 | 11-6 | 9-4 | 10-6 | 9-6 | 9-6 | 15-6 | 9-0 |
| Total wheel base (one unit), ft-in. | 24-6 | 29-2 | 29-9 | 31-1 | 43-9 | 43-9 | 39-4 | 40-6 | 39-6 | 36-6 | 64-6 | 189-0 |
| Weight on drivers, lb | 95000 | 141000 | 150000 | 139000 | 163300 | 176000 | 230000 | 166600 | 244000 | 254000 | 250000 | 920000 |
| Total locomotive weight, lb | 95000 | 141000 | 150000 | 139000 | 245000 | 266000 | 230000 | 250000 | 244000 | 254000 | 375000 | 920000 |
| Fuel capacity, total gallons | 250 | 400 | 500 | 500 | 1000 | 1000 | 800 | 800 | 1700 | 1200 | 1500 | 4800 |
| Driving wheel diam, in. | 33 | 33 | 33 | 36 | 42 | 42 | 40 | 40 | 42 | 42 | 40 | 40 |
| Track gage, in. | 39⅜ | 39⅜ | 36 | 56½ | 56½ | 56½ | 56½ | 56½ | 56½ | 56½ | 56½ | 56½ |
| Max permissible speed, mph | 50 | 50 | 35 | 55 | 65 | 82 | 65 | 65 | 65-85[l] | 65 | 89 | 65-95[l] |

NOTES FOR TABLE 4:

[a] P = passenger; F = freight; Rd Sw = road switcher; Sw = switcher.
[b] General Electric Co.
[c] Sorocabana Ry. of Brazil.
[d] V-type engine.
[e] Caterpillar Tractor Co.
[f] Cooper-Bessemer Corp.
[g] American Locomotive Co., General Electric Co.
[h] Baldwin Locomotive Works.
[i] Columbus & Greenville Ry.
[j] Fairbanks, Morse & Co.
[k] Opposed pistons (two pistons per cylinder).
[l] For various gear ratios.
[m] Central Railroad Co. of New Jersey.
[n] Electro-Motive Division, General Motors Corp.

in Fig. 19, these locomotives, used in copper mines, can operate both under a trolley and on track not equipped with overhead construction. In the latter operation, electric power is supplied by 325-hp Sterling Diesel engine generators, two of which are built into each locomotive.

### DIESEL-ELECTRIC LOCOMOTIVES

Many new designs of Diesel-electric locomotives have made their appearance during the year. The wide range of services to which this type of power is applicable is discussed in the following.

In Brazil, extensive dieselization of branch lines is well under way. The fuel situation (wood and coal) and the cost of foreign coal imports are such that Brazil finds it economically advantageous to import oil for Diesel-electric locomotives to augment the electric power employed on electrified main lines.

Item 1, Table 4, and Fig. 20, describe and illustrate a 43-metric-ton, 330 hp locomotive for the Sorocabana Railway. A six-axle 64-metric-ton unit with all weight on drivers, pictured in Fig. 21, is another type being used extensively. Details of the latter are given in item 2, Table 4. Both of these units are equipped for multiple-unit operation, locomotive air brakes, and vacuum-brake train operation.

Another unit featuring lightweight per axle, all weight on drivers and high horsepower is described in item 3, Table 4. Built by the H. K. Porter Company for U. S. Gypsum, this locomotive, shown in Fig. 22, could be adapted to railroad use where flexibility and light axle loadings are requisites.

In the United States, the American Locomotive and General Electric Companies have delivered new 70-ton 600-hp units to various domestic railroads. Described in item 4, Table 4, these locomotives are designed for flexible operation and are being used extensively for branch-line operation. Fig. 23 illustrates one of these locomotives in service on the Saratoga & Schuylerville Railroad.

The Baldwin Locomotive Works have developed a new line of 1500-hp locomotives designed for various services. The first of these, described in item 5, Table 4, and illustrated in Fig 24, has been placed in freight and road-switching service on the Columbus and Greenville Railway. Item 6, Table 4, gives the details of this locomotive adapted to passenger service. Many of these locomotives have been delivered to France to aid in the rehabilitation of her railways.

Item 7, Table 4, lists the details of a new line of 1500-hp road switchers which have been delivered to various domestic railroads during the year by Alco-GE. A four-axle unit for the Delaware & Hudson is pictured in Fig. 25. Fig. 26 illustrates a similar locomotive using six axles with four-motor drive which is in service on the Milwaukee Railroad. Details of the latter are given in item 8, Table 4.

Fairbanks-Morse has delivered to several domestic railroads two new types of heavy-duty locomotives. The first, described in item 9, Table 4, and illustrated in Fig. 27, is a 1500-hp unit designed for passenger, freight, and road-switching service and may be equipped with a train-heating boiler. The second design, described in item 10, Table 4, and illustrated in Fig. 28, is the first four-axle Diesel-electric unit to have a rating of 2000 hp. The latter is being used for road-switching operation.

FIG. 25 1500-HP ROAD SWITCHER FOR THE DELAWARE & HUDSON RAILROAD

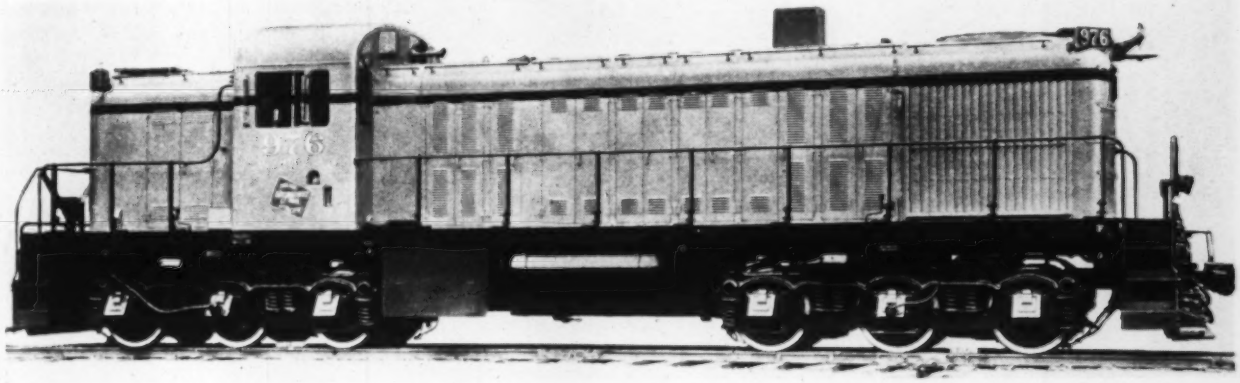


FIG. 26 1500-HP ROAD SWITCHER FOR THE MILWAUKEE RAILROAD

FIG. 27 FAIRBANKS-MORSE MIXED-SERVICE UNIT

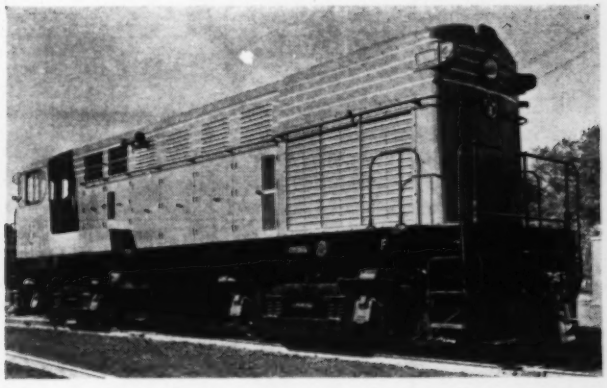

FIG. 28 FOUR-AXLE 2000-HP HEAVY-DUTY LOCOMOTIVE

Fig. 29 illustrates a Diesel-electric locomotive designed for suburban passenger service. Several have been placed in operation by the Central Railroad Company of New Jersey. A description of this 2000-hp locomotive, built by Baldwin Locomotive Works, is given in item 11, Table 4. A notable feature of design is the use of double-end operating cabs on each streamlined unit.

Fig. 30 illustrates the F-3 locomotive built by the Electro-Motive Division of General Motors Corporation for various domestic railroads. Described in item 12, Table 4, the locomotive is designed to meet the needs for flexible performance and adaptability to a wide range of services from heavy-duty freight to fast passenger service.

### STEAM TURBINE - ELECTRIC LOCOMOTIVES

The latest endeavor in the application of the steam-turbine for locomotive use is exemplified in the coal-burning noncondensing units, three of which have been completed by Baldwin-Westinghouse for passenger service on the Chesapeake and Ohio Railway between Washington and Cincinnati, Figs. 31 and 32.

Housed in the forward part of the locomotive is the coal hopper from which the fuel is fed to the firebox by a mechanical

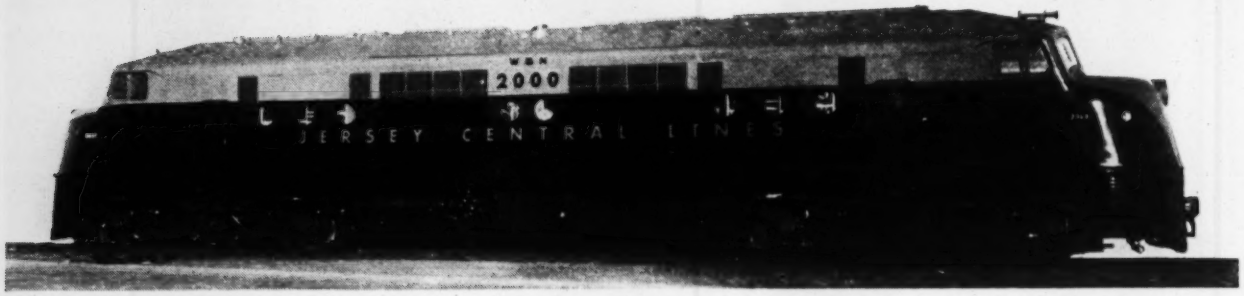


FIG. 29 SUBURBAN PASSENGER LOCOMOTIVE FOR THE JERSEY CENTRAL

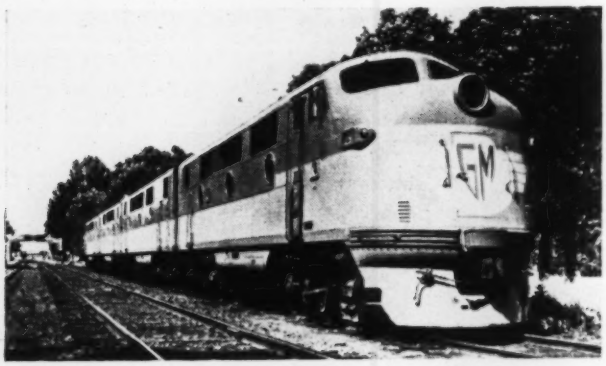


FIG. 30 FOUR-UNIT 6000-HP GENERAL-PURPOSE DIESEL-ELECTRIC

FIG. 31 STEAM-TURBINE ELECTRIC FOR THE CHESAPEAKE AND OHIO RAILWAY

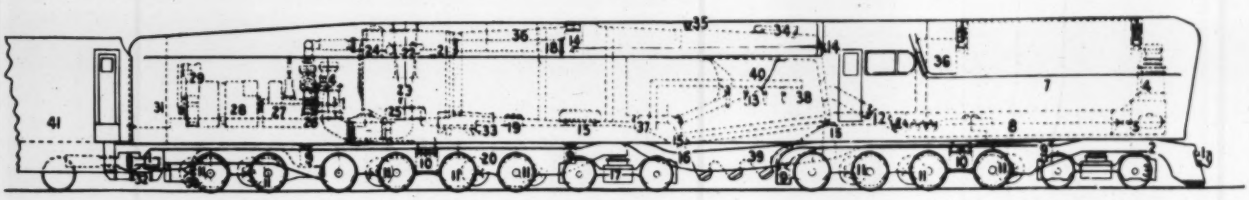

FIG. 32 DIAGRAM SHOWING LOCATION OF PRINCIPAL PARTS OF C. & O. STEAM TURBINE-ELECTRIC LOCOMOTIVE

1 Pilot coupler
2 Main frame (front unit)
3 Engine truck
4 Turbo-traction motor blowers (3)
5 Stoker engine
6 Coal-hatch-operating cylinders (4)
7 Coal bunker
8 Stoker conveyer
9 Sliding spring supports (7)
10 Center pins (2) (main frames)
11 Traction motors (8)
12 Stoker elevator pipe
13 Boiler
14 Steam shut-off valve and handle
15 Boiler supports-sliding (5)
16 Cab underframe
17 Intermediate truck
18 Dry pipe
19 Mechanical lubricator
20 Main frame (rear unit)
21 Superheater header
22 Exhaust stack
23 Exhaust nozzle
24 Feedwater heater
25 Boiler support-fixed
26 Main turbine
27 Reduction gearing
28 Generators (2)
29 Exciters (2)
30 Trailing truck
31 Control compartment
32 Spring buffer
33 Hot pump
34 Steam valve stand
35 Safety valves
36 Sand box (2)
37 Smoke-consumer turbine
38 Smoke consumers
39 Ash pan
40 Syphons (3)
41 Tender

TABLE 5 STEAM TURBINE-ELECTRIC LOCOMOTIVE

| | |
|---|---|
| Rated horsepower | 6000 |
| Working steam pressure, psi | 310 |
| Heating surface, sq ft | 4406 |
| Superheating surface, sq ft | 1770 |
| Grate area, sq ft | 112 |
| Driving wheel, diam in. | 40 |
| Wheel base, rigid, ft-in. | 17-6 |
| Wheel base, total engine, ft-in. | 90-7 |
| Wheel base, engine and tender, ft-in. | 140-3 3/4 |
| Weight, on drivers, lb | 508000 |
| Weight, total engine, lb | 823000 |
| Weight of tender, lb | 371800 |
| Tank capacity (water), US gal | 25000 |
| Fuel capacity (coal), tons | 29 1/4 |

EQUIPMENT: Type E superheater, feedwater heater, stoker, 3 thermic syphons, cast-steel locomotive beds. Air brake on all driving, intermediate truck, trailer-truck, and tender wheels. Electropneumatic brakes with speed-governor control.

stoker. Directly behind the coal hopper is the operator's compartment. A conventional fire-tube boiler and firebox occupy the center section, while the turbine and generators are placed at the rear of the locomotive unit. A water-carrying tender is placed directly behind the motive-power unit. Salient characteristics are given in Table 5.

### FREIGHT CARS

In studying the new and unusual developments in freight and passenger cars throughout the past year, one becomes keenly aware of a broad interest in revitalizing the railroads which seems to have permeated every section of the industry. The drawing boards and the designers' "idea pads" are crammed.

For the purposes of this report, it has been deemed advisable to confine the data given to features already constructed, although there are many challenging proposals still in the idea stage.

It is realized that the mortality of new ideas in any industry, between conception and application, is great; but by sheer weight of averages, the railroad field should find more new and startling ideas in actual use in the next few years than ever before. The practical needs of production for the present, which are taxing most carbuilding plants, coupled with the still bothersome material shortage, are the only factors holding back many innovations at the present time.

Universal attention has been focused on the country's need for additional freight cars. With a view toward assisting boxcar manufacture, Pullman-Standard has designed and developed the P-S-1 (Fig. 33). The principal feature of the new car is that more of its parts will be standardized; and this, it is hoped, will speed boxcar production and reduce costs.

This unit utilizes the welded underframe construction which has had broad approval in experience and tests. The ends are pressed in two sections, riveted together, featuring deep corrugations running from side to side to transfer the forces of shifting loads to the sides. The sides are of the automatic submerged arc-welded type, providing integral butt-welding of the sheets to a depth that includes the Z-bar side posts in the weld. Side sheets are placed on the outside of the side sill and the side plate and are continuously arc-welded to the side sheets.

The P-S-1 is available with either a riveted or an arc-welded roof. The riveted roof is built up with roof sheets and carlines, the latter standing up on the outside of the car. The carlines are pressed hairpin steel sections, forming a cap of water-shedding construction. The welded roof, built up by automatic submerged arcwelding, is a permanently watertight integral unit. The copper-bearing nongalvanized steel roof sheets are continuous-arc-welded to the top of the side plate. The roof sheets incorporate a pan-shaped pressing for stability and stiffness.

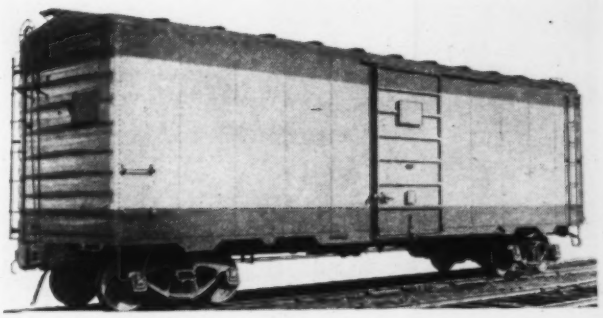

FIG. 33 PULLMAN-STANDARD BUILT P-S-1 BOXCAR

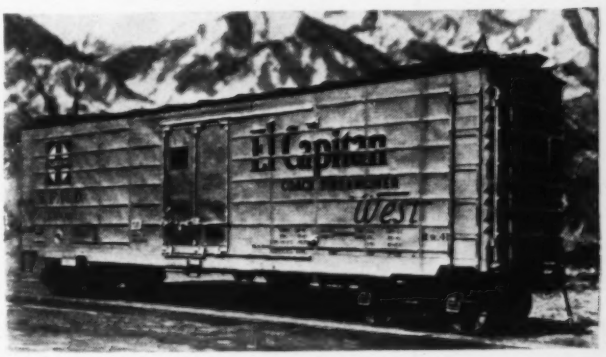

FIG. 34 STAINLESS-STEEL REFRIGERATOR CAR

A new 40-ft 40-ton stainless-steel refrigerator car, built for the Atchison, Topeka & Santa Fe by the Consolidated Steel Corporation, has been placed in experimental service. This car, illustrated in Fig. 34, utilizes welded steel construction. The lightweight of the car is 57,200 lb, and the load limit is 78,800 lb. Water ice is used as a refrigerant.

Construction of the underframe includes a center sill of Grade A steel and bolsters of Yoloy, a weldable high-yield-point low-alloy steel. The center sill is reinforced at the ends by welding plate and bar material to eliminate the usual heavy striker castings. Welding is used to achieve maximum strength with minimum weight. The car ends are stainless-clad steel, Dreadnaught-type, made by the Standard Railway Equipment Company. The hot-dipped galvanized roof is a product of the same company. Side sheathing is 18 gage, 18 per cent chrome, 8 per cent nickel, cold-rolled. To avoid distortion in welding horizontal ribs are pressed in the sheets, thus permitting welding of the side sheets to the frames on all four sides with a minimum of wrinkling. The car is equipped with ASF Type A-3 Ride-Control trucks with 5 × 9-in. waste-packed journals and 33-in. one-wear wrought-steel wheels.

Reverse forced-air circulation is supplied in the car by means of Preco fans driven from the car wheels or by electric motors which are slipped on mounting brackets when the car is standing. For frozen loads, cool air is circulated along the inside of the insulated walls instead of through the load. A lever over each side door operates louvers along the top of the sides extending the length of the car between bulkheads, opening or closing 1-in. air ducts inside the walls and doors. When these louvers are closed, the ducts form an additional 1-in. dead-air-space insulation along the car sides and doors. The convertible bunkers are of lightweight design and take full advantage of forced-air circulation by providing maximum ice surface exposed to the circulating air. A unique feature of the car is the use of a new sliding-type door which gives the same 6-ft opening as in

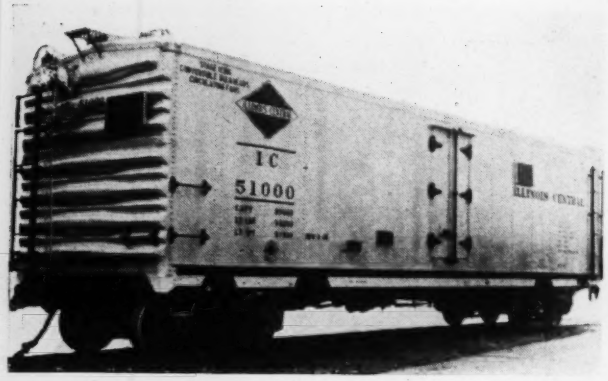


FIG. 35 EXPERIMENTAL ALUMINUM REFRIGERATOR CAR

FIG. 36 ALUMINUM HOPPER CAR

a standard boxcar and uses the well-known toggle principle, permitting great pressure at the side jambs with little manual effort.

Two aluminum refrigerator cars have been placed in experimental service in the past year, one by the Illinois Central and the other by the Fruit Growers Express Company.

The Illinois Central car, illustrated in Fig. 35, was built at the McComb, Miss., shops of the railroad. It is a 40-ton all-purpose car with a lightweight of 51,500 lb. Plans for this new car were formulated through co-operation of the railroad and the Refrigerator Car Committee of the United Fresh Fruit & Vegetable Association. Collaborating in details of design were the Aluminum Company of America, which furnished the aluminum alloys, a number of specialty manufacturers and the Car Construction Committee of the Association of American Railroads. The car, equipped with A-3 Ride-Control trucks, incorporates the following features recommended by the Committee: Standard interior dimensions; effective insulation; Preco built-in fans for improved circulation; iceboxes with convertible bulkheads to fold back and allow about a 6-ft increase in interior length of the car when used in nonrefrigerated loading; inner guard to slide in place along the ceiling and prevent pilfering via the ice-loading hatches; electric lights for loading and unloading.

The Fruit Growers Express car, built for a 40-ton normal capacity and having a lightweight of 50,600 lb, also included the committee's recommendations. In addition to the extensive use of aluminum alloys, features of the car include the installation of part-stage icing devices, fan-circulated cool air, built-in electric lights, thermometer equipment permitting the reading of inside temperatures from the outside of the car, and door thresholds flush with the top of the floor racks to make trucking operations easier. The center sill, bolsters, and crossbearers are steel; and a cast-steel bolster center filler is used with rear draft lug and built-up welded strikers. End sills and side sills are aluminum. The car is equipped with conventional AAR trucks, having 5 × 9-in Timken roller bearings applied to existing Andrews-type side frames, and one-wear rolled-steel wheels mounted on special machined-end full AAR axles.

What is believed to be the first production order for aluminum hopper cars was completed early in 1946. The order consisted of 25 triple hopper cars for the Missouri Pacific Railroad built by the American Car and Foundry Company. Each car (Fig. 36) is 45 ft $^1/_2$ in. long over the strikers, 10 ft 8 in. high above the rail and 10 ft 4 in. wide inside, and has a lightweight of 37,000 lb. As compared to the AAR standard 70-ton steel hopper car of 50,100 lb, there is a weight saving of 13,100 lb. This difference is utilized to increase the pay load $6^1/_2$ tons, this being accomplished by adding $39^1/_4$ in. to the length of the car and increasing the capacity 240 cu ft. The basic design of the new car conforms to the AAR 70-ton standard, and the weight savings are secured without reduction in the thickness of sheets and plates used in construction. The entire body is built of aluminum except for the center sill and bolsters, which are carbon steel. The cars are mounted on unit-type trucks with cast-steel side frames and bolsters, and 6 × 11-in. axles with plain journal bearings. One-wear steel wheels are provided.

Application of roller bearings to freight equipment has been the subject of study for some time. Some cars in fast merchandise service were thus equipped as early as 1939.[2] Recently, however, there are indications that this technique will be more broadly applied.

Presently, 300 Union Pacific stock cars are being reconditioned for high-speed service and used in nonstop Diesel-powered freight trains between Salt Lake City and Los Angeles, reducing the running time westbound by 50 per cent. Two single-row Timken bearings are used in a special housing which is designed to utilize existing side frames which have the old journal boxes cast integral.

Other applications of the roller-bearing technique which are being planned include 500 Railway Express Company cars and 1000 70-ton hopper cars for the Chesapeake and Ohio.

Word has come out of Germany through the Office of Technical Services of the Department of Commerce that considerable success is being enjoyed by German industry in the use of cast concrete as a substitute for steel. Of interest to the railroad trade is the use of prestressed reinforced concrete to make freight cars. Investigators report that all parts of the car except the wheels, springs, and drawbars are made of cast concrete.

A few test gondola cars built of concrete were tried out in this country about the time of World War I but were only used experimentally.

### PASSENGER CARS

The most significant departure from the conventional in railroad trains produced during the year was the "Train of Tomorrow," the cars of which were built by Pullman-Standard for the General Motors Corporation (Fig. 37).

The train, powered by a 2000-hp Diesel-electric locomotive built by General Motors, consists of a coach, diner, sleeper, and a bar-observation car. Each car is characterized by a raised glass-enclosed section known as an "Astra-Dome," rising about 2 ft above the conventional roof level. Each dome is a section from which passengers, sitting in regular coach seats, may view the passing scene. To permit the normal clearance below the floor of the dome sections, it became necessary to depress the floor of the car throughout this section. This led to extensive and interesting modifications in normal car construction (Fig. 38). To test out the accuracy of the design, several physical tests were conducted consisting of the following: Static load

[2] "Progress in Railway Mechanical Engineering, 1943–1944," MECHANICAL ENGINEERING, vol. 66, 1944, pp. 783–798.

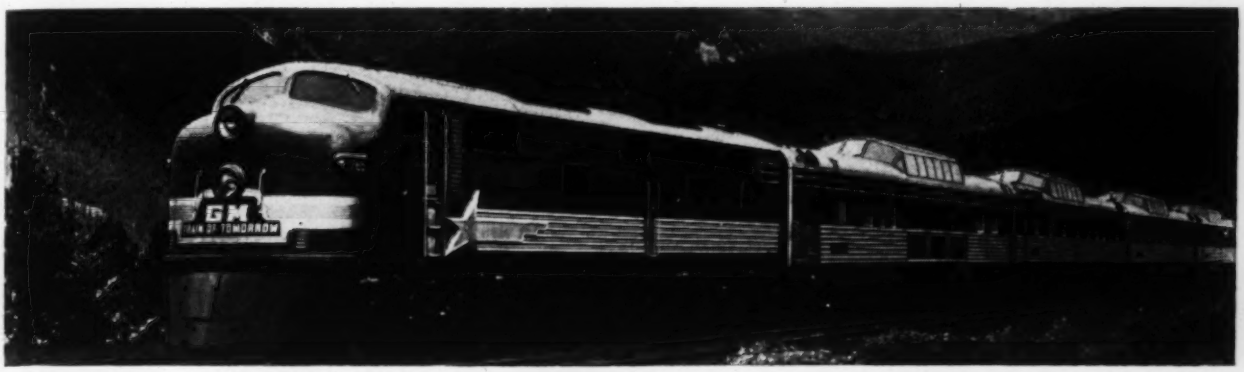


FIG. 37 GENERAL MOTORS "TRAIN OF TOMORROW"

test, torsional jacking test, and AAR compression or squeeze test.

Each car is equipped with a Diesel-engine power unit located beneath the car. The unit provides power for air conditioning, ventilation, and lighting independent of the power from the locomotive. The diner has an additional Diesel-electric power system in the body of the car for the all-electric kitchen.

Predominant features of the chair car are noted in the evident comfort, lighting, color, and utility of space. The chairs, "Sleepy Hollow" design, are distributed as follows: The dome, 24; each forward and rear main section, 28; the depressed lower level, 20. This depressed lower section has three semiprivate compartments, two of which seat 7 persons each and the other, 6. These are ideally arranged for occupancy by groups.

The dining car is the first in America to be equipped with an all-electric kitchen and pantry. Table service is provided on three levels. In the dome, 18 people may dine in a roof-garden atmosphere. The largest dining section, in the rear of the car on the main level, seats 24 in two- and four-place diagonal tables. The third section, in the depressed area, is composed of a private dining room with two tables, each seating 5 persons.

Design of the sleeping car provides approximately 50 per cent more free floor space in drawing rooms and compartments during daytime occupancy than in ordinary sleeping cars. The car has sleeping accommodations for 20 persons and seats for 24 persons in the dome section. Sleeping arrangements consist of two drawing rooms in the forward main level of the car, each with three berths; three compartments, with two lower berths each, in the depressed level of the car; and eight duplex roomettes in the rear main level of the car. All berths are installed lengthwise.

The lounge car has a total of 68 seats, more than half of which are movable, permitting flexibility of group formations. There are a variety of diverting and surprising travel innovations. On the lower level of the car, in the depressed area, is the "Top O' the Rail Bar," with wall seats, chairs, and tables forming an informal cocktail lounge. The forward section, on the main level, is a somewhat larger cocktail lounge.

Another adaptation of the "dome" idea in carbuilding is being applied by the Budd Manufacturing Company to its "Vista-Dome" cars being delivered to the Burlington. Illustrated in Fig 39, the car has no depressed section in the underframe, the dome being built atop a conventional car structure and reached by steps leading from the standard car level. There is a slight recess in the floor of the main level to allow more headroom under the dome. Each dome seats 24 passengers. The coaches are luxuriously appointed with soft carpets, fluorescent lighting, painted murals, and modern color schemes. The domes, with rounded instead of angled framework, are

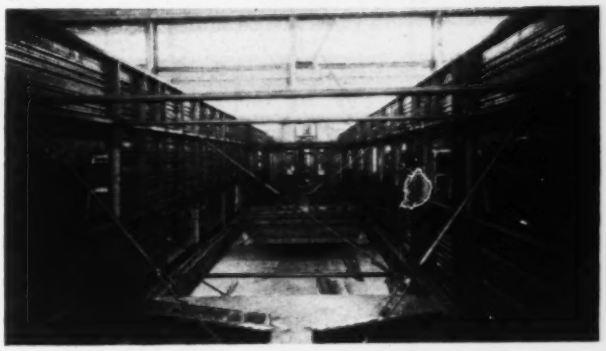

FIG. 38 CONSTRUCTION DETAILS OF ASTRA-DOME CAR

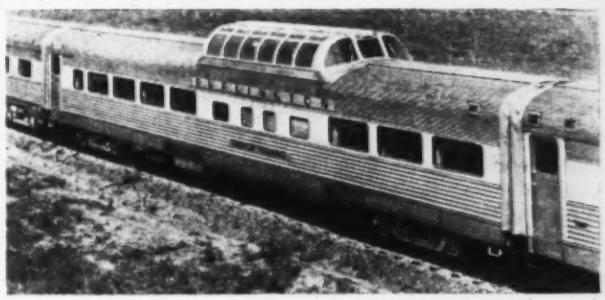

FIG. 39 BUDD VISTA-DOME CAR

enclosed in double layers of glass—an outer layer which is 1/4 in. thick, tempered and heat-resisting, tinted green; then 1/4 in. of air space; and then an inner layer of 1/4-in. laminated safety glass. The cars are equipped with the latest type Budd disk brakes, providing faster smoother stops and reducing wear on wheels. The brakes are equipped with the no-slip feature eliminating wheel-slide.

Fig. 40 illustrates a dining car built by Pullman-Standard in which the tables are placed diagonally and seats are set at a 45-degree angle to the side of the car instead of at right angles as in ordinary diners. This arrangement adds to efficiency in car operation as well as to passenger comfort because it accelerates service, eliminates interruptions caused by arrivals and departures at the tables and enables waiters to step to the side when serving, thus keeping the aisle free at all times. Diners incorporating this innovation are already in operation on the new Pere Marquettes and the new streamliners of the Chicago & Eastern Illinois Railroad.

America's railroads received their first completely new busi-

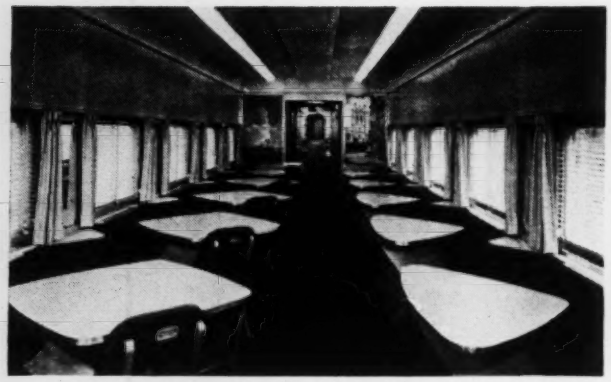

FIG. 40 CHICAGO & EASTERN ILLINOIS DIAGONAL SEAT DINER

FIG. 41 LONG ISLAND RAILROAD'S DOUBLE-DECK CAR

ness car in more than 15 years when Pullman-Standard delivered such a car to the Great Northern. The car, built to match the new "Empire Builder" trains, provides two master bedrooms, one private bedroom, one secretary's room, a 13-ft 9-in. dining room which accommodates 12 persons and a 12-ft 7-in. observation room with five chairs and a sofa seating three. The sofa also opens into a berth. The observation platform is open with low railings and a low gate. The car also has servants' quarters for two and a kitchen and pantry.

New sleeping accommodations which have made their appearance are modifications of those in existence before the war, but they have been refined to a considerable extent considering the limitations of such designing. Pullman-Standard has designed the "double bedroom—new," in which each room is crosswise, the lower bed being of the premade, folding roomette type. Both the lower and upper beds are crosswise. Additional features of the room include two contoured movable chairs, toilet facilities in a private annex, wardrobe locker, and luggage space above the annex. Improvements in passenger comfort include the piping of circulating mechanically cooled drinking water to the bedroom and individual thermostatic heat and air-conditioning controls within the space. A folding partition connects two of these rooms in a pair or ensuite. A pair of these bedrooms occupy 11 ft 8 in., and 12 of them can be placed in a car.

A new approach to the bedroom accommodation, using the same amount of space and embodying similar improvements, has made its appearance in the Budd double-bedroom car. Each double bedroom consists of two bedrooms which are compatibly designed for pairing—one utilizing crosswise beds and the other, lengthwise beds. The crosswise room has a contoured sofa which folds down to form the lower berth, and the upper berth folds down in conventional fashion. The lengthwise room has a roomette-type seat and a folding chair. The lower berth folds down in the conventional roomette fashion with a double pivot-type upper berth above it.

The same company has introduced two types of rooms for single occupancy. The Budd "A" cabin is arranged with the wash-basin and wardrobe facilities placed on the side of the room instead of the end. A premade berth is lowered from the wall, as in the roomette. Individually controlled no-draft air conditioning, fluorescent lighting, and a sliding table further contribute to passenger comfort. The Budd "B" cabin features an unusual berth arrangement. By narrowing slightly the foot end of the berth, it is possible for the passenger to lower the bed while standing entirely within the room with the door closed.

The Long Island Railroad has placed in suburban service ten double-deck passenger cars for its electrified line (Fig. 41). Six of the cars are power cars, having two 230-hp motors and one truck, and having one truck without motors. The other four are known as trailer cars and are not equipped with motors. With the exception of the trucks, the two classes of cars are similar. The bodies are of aluminum construction. They are air-conditioned and equipped with recessed lighting. Each car seats 64 passengers in the upper tier, and 68 passengers in the lower level, a total of 132 passengers per car. The power cars weight 115,600 lb and the trailers weigh 99,325 lb.

### GAS TURBINE-ELECTRIC LOCOMOTIVES

Considerable research and development are being continued by several concerns, both domestic and foreign, on the application of the gas turbine for locomotive use. The Locomotive Development Committee of Bituminous Coal Research, Inc., continued its activities in the development of coal-burning locomotives of this type and is contemplating placing orders with two locomotive builders for pilot models. An order for an oil-burning version of the gas turbine-electric for a domestic railroad is being processed by one of the locomotive builders.

Following successful trials of its 2200-hp oil-burning gas turbine-electric locomotive built for the Swiss Federal Railways, Brown Boveri Company has constructed a 3000-kw (4000-hp) experimental locomotive power plant, Fig. 42, for eventual inclusion in a locomotive chassis. Unique in this plant is the "Comprex" booster which is, in effect, an added stage of compression, utilizing a "piston" of hot gas to compress a charge of relatively cool air. This added stage of compression increases the power output from the set by about 50 per cent of that possible with a simple open-cycle unit of comparable physical dimensions.

### POPPET VALVES

With a view to increasing the efficiency of the conventional steam locomotive, a number of railroads have applied poppet valves to selected units for experimental purposes, and the Pennsylvania Railroad is currently operating a fleet of 50 locomotives built with this type of valve gear. Since 1939, and up to early 1947, 65 locomotives equipped with this type of valve were operating in the United States. A notable application to a number of three-cylinder locomotives, British-built for service in Malaya, is reported elsewhere in this survey.

The Type B continuous-contour rotary-cam gear, prototype of which has operated on Pennsylvania K-4's since 1945, has been brought out as an improvement over the Type A gear using oscillating cams for actuating the valves.

### WELDED BOILERS

During the past year, there have been placed in service 23 all-welded boilers associated with rebuilt locomotives ranging

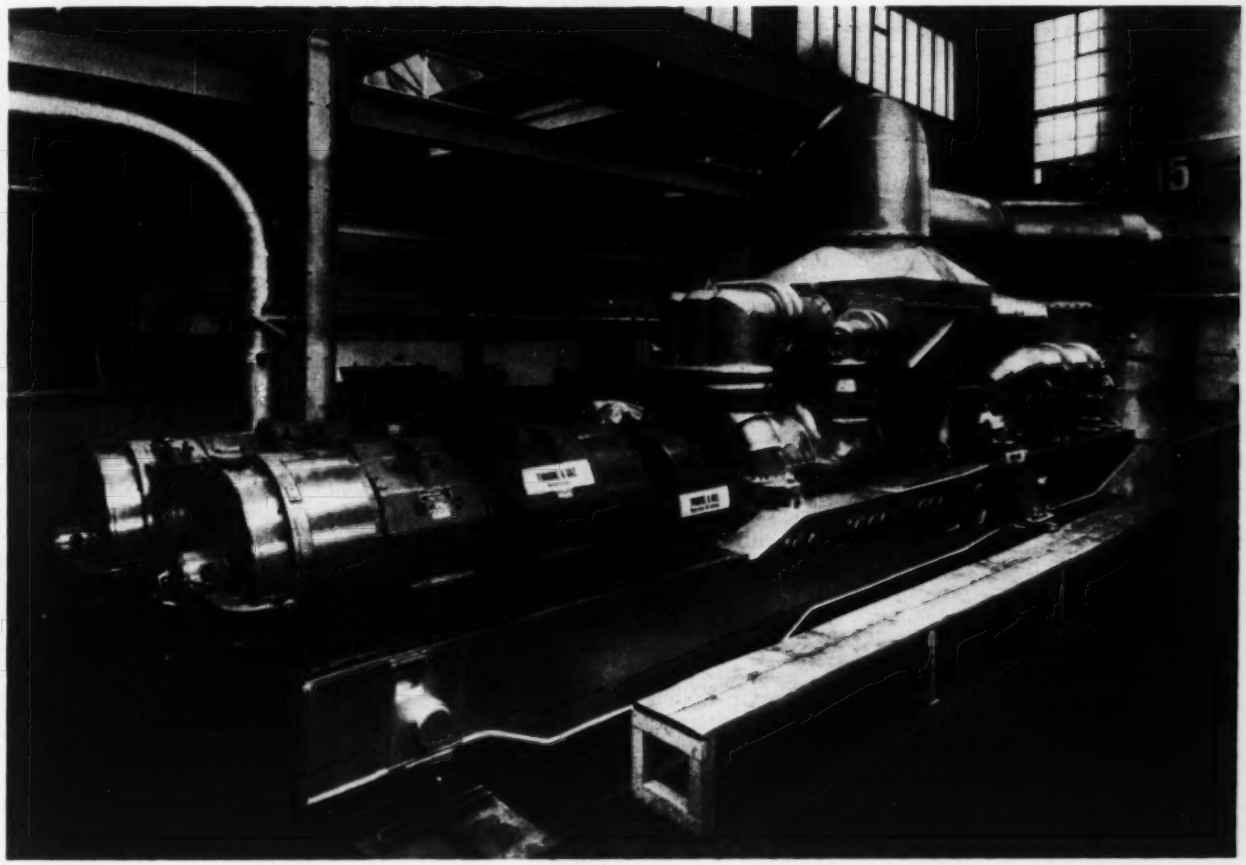

FIG. 42 GAS TURBINE-ELECTRIC UNIT FOR SWISS LOCOMOTIVE

from Pacific to Mallet types. All welds in the boilers are radiographed and furnace stress-relieved.

The welded boilers are covered by specifications approved by the Bureau of Locomotive Inspection of the Interstate Commerce Commission.

ACKNOWLEDGMENT

The committee gratefully acknowledges the assistance in securing data for the report rendered by the railway press of the United States; by the *Railway Gazette* of Great Britain; by the railroads; by the various domestic locomotive, car, and equipment manufacturers; by the U.S. Department of Commerce; by Secheron and Brown Boveri of Switzerland; by Nydqvist and Holm of Sweden; by the New Zealand Railways, and by Mr. R. M. Coultas of the General Electric Company, who assisted greatly in gathering data and in the compilation of the report.

## Flow of Coal in Chutes

(*Continued from page 314*)

report, necessitated certain undesirable compromises. In the design of structural steel for the new unit at Riverside Station this was taken into account and some of the obstructions were eliminated by rearrangement of a few main framing members. However, interferences caused by the air heaters and duct systems could not be alleviated and had to be reckoned with in this design as well as in the previous one. The rearrangement of structural steel made it possible to eliminate the hopper section at the point where the two legs from the bunker gates converge. Further simplification was gained in co-operation with the Babcock & Wilcox Company by providing a larger feeder, placed at a different point on the mill, thereby permitting a larger minimum section for the chute and eliminating one lateral transition. The design to be installed for unit No. 3 is shown in Fig. 4. All of the portions from the upper hoppers to elevation 31 ft 6 in. are expanding sections, and the maximum velocity of coal will be considerably below that in the former design.

Therefore this new design has incorporated the following improvements:

1 Elimination of converging section at a point which is not readily accessible from the operating floor.

2 Larger capacity of chute system and consequently lower velocity of coal through chutes.

3 Larger area and more favorable arrangement of mill-feeder inlet at bottom of hopper below operating floor.

4 Use of 20 per cent stainless-clad steel throughout the coal-chute system to reduce maintenance, in view of experience gained with the experimental chute.

For the third unit now under construction at Riverside, two of the three chutes, namely, the north and south chutes, will be essentially the same as the original Riverside chutes with rectangular cross section. The third, or center chute, will be of the new type designed through laboratory experiments. It is the purpose of these experimental installations to make whatever progress can be accomplished in successive steps of laboratory tests and field experience before markedly different designs are incorporated for all coal chutes in the actual structure.

# BANKRUPTCY OF "INTERNATIONALIST" THINKING[1]

By THOMAS E. BAKER

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DESPITE the events of the last thirty years, many modern "experts" on international relations continue to find the single cause and the simple solution for the problems which confront the nations of the world. Plan after plan is suggested as individual after individual discovers the root of evil. The simplicity of each plan and the obviousness of each single cause garner support from large segments of the American public which fail to see that politics in both the domestic and international spheres is a struggle for power. Sickened by the apparently endless bickering, vacillation, deadlock, or compromise in international conferences, these groups rally around one plan after another which oversimplify the problems and neglect the actual conflicting forces.

### SEARCH FOR SIMPLE SOLUTIONS

The search for the "single cause" and the discovery of simple solutions for world conflict is not a monopoly of the twentieth century. Certain nineteenth century thinkers guaranteed peace to the world if aristocratic governments were overthrown everywhere or if all tariffs were removed or if secret diplomacy were replaced by popular control of national policies. Even the Marxists promised no more war if capitalism-imperialism were destroyed and socialism established.

To these solutions, twentieth-century thinkers added a host of others, each one offered as the means for preventing war. Here are some of the discovered causes and the solutions which have been tried.

Since there has been no machinery to settle disputes peacefully, all nations should submit their disputes to courts of arbitration or to a world court. Since many wars begin over boundary disputes, people in these areas should decide for themselves by plebiscites to which nation they wish to belong. Because the nations of the world are not organized, an international organization should be formed. All wars are fought with arms, so armaments should be reduced or outlawed and thus give all nations security. Or, guarantee security to all nations and then disarm. All nations should agree not to take any aggressive action against another nation. Because a nation will wage war if it cannot trade, war can be avoided if tariffs are lowered, resources redistributed, and international loans floated. The League of Nations failed to prevent war because of the absence of the United States and the weaknesses in the League's machinery; war will be prevented, therefore, if the United States joins a new world organization which has corrected the technical weaknesses of the League. There will be no war if aggressor nations such as Germany, Italy, and Japan are reduced to the level of agrarian economies and re-educated in the ways of democracy. "National sovereignty" is the cause of war; so all national sovereignities should be pooled in a world federation.

This is, of course, only a minute sample of the proposed plans, and it must be pointed out that in the last twenty years the United States has indulged in similar thinking along lines peculiarly its own. Because it appeared that the United States was involved in World War I by the actions of belligerent nations in violation of American neutral rights and by the plots of American bankers and manufacturers of munitions, the United States attempted to avoid a future world war by renouncing certain rights for American ships and citizens in portions of the high seas in wartime and by imposing curbs on loans and exports.

After the war, other plans have appeared in the United States. If the American and Russian people knew one another better, there would be no war. Or, because Russia is the source of all danger for the United States, the United States should bomb and destroy Russia completely.

The list of these simple proposals in the United States is almost endless, limited only by the number and the imagination of writers and speakers on international relations. Many of these people are inspired to continue their writing and speaking by the greatly increased interest of the American public in international relations.

### INTERNATIONALISTS ATTEMPTING TO ESCAPE

Both groups of "internationalists," spokesmen and public, are attempting to escape. They are running away from the realities of community and national politics to enter a world of speculation which entails no sacrifices or risks or any changes in their manner of living. Only the very courageous enter the turmoil of domestic politics when they discover the close bond between international and national problems.

Writers and speakers are encouraged by their public to continue their search for single causes and simple solutions. People expect revelations or, if this is impossible, presentations of views which agree with some prevalent program. The writer, for example, will not confess his confusion or present a complex analysis without adding a clear solution. He knows that in either case he will have difficulty in publishing his book. And if such a book is published, it has few readers. Perhaps his greatest fear, however, is that he will be accused of lack of originality or creative ability if he has not proposed a "constructive plan." The writer is likely to feel that it is better to give a slightly new twist to an old plan than to have none at all! It is better to rewrite an old simple idea than not to write at all!

The speaker has the same considerations in mind, although he often approaches the problem of simplicity in a blunter fashion. The popular speaker finds it far more satisfactory to speak absolutely for or absolutely against a particular proposal. On the Palestine problem, for example, the man who presents the problem as a confusion of conflicting interests without a simple solution will win no support from the audience but will encourage and receive criticism from the supporters of all parties concerned in the dispute. If the speaker, on the other hand, advances an argument in favor of one side of

[1] One of a series of reviews of current economic literature affecting engineering prepared by members of the Department of Economics and Social Science, Massachusetts Institute of Technology, at the request of the Management Division of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Opinions expressed are those of the reviewer.

the dispute and appeals to both reason and emotion, he will receive the rabid vocal support of at least a good portion of his audience.

Aside from these considerations, if he can afford to disregard this, the social scientist today still attempts to find fundamental laws and formulas. Fascinated by the results produced by the application of reason in the physical sciences, the social scientist continues to assume that all political problems can be solved exactly like problems in mathematics and physics. He disregards the lessons of experience such as the failure of past formulas. He retains his assumption that human actions are primarily motivated by reason and can be controlled by reason. That politics is identical with unreason is a belief shared by the social scientist with the general public.

As Professor Hans Morgenthau[2] points out, the social scientist has failed to understand the nature of man; the nature of the world, especially of the social world; and, finally, the nature of reason, since reason itself submits to the control of irrational forces. Man is both an irrational and a rational animal. Politics is always a struggle for power over man and is inseparable from social life. In addition, the social scientist has misunderstood modern scientific thought in the physical sciences where general theories and statistical probability have replaced the certainty of the nineteenth century.

### THE CHIMERA OF CERTAINTY

The social scientist today is following a chimera, *certainty*. Unlike men in the physical sciences, men in the social sciences are unwilling to admit that certainty cannot be attained. Unlike A. S. Eddington, they will not say, "Something unknown is doing we don't know what—that is what our theory amounts to."

Professor Morgenthau believes that social scientists must not only give up their fruitless search but must also realize that the social world is deaf to a pure appeal to reason. The world will yield "only to that intricate combination of moral and material pressures which the art of the statesman creates and maintains. . . . As Goethe's wisdom put it: 'While trying to improve evils in men and circumstances which cannot be improved, one loses time and makes things worse; instead, one ought to accept the evils, as it were, as raw materials and then seek to counterbalance them.'" Any decision made by the true statesman is made only after a careful consideration of the possible effects of the decision upon the distribution of power in both the national and international spheres.

Although Professor Morgenthau very carefully follows his own thesis and does not attempt to provide any solutions for the problems which he presents, he does indicate his belief that the bankruptcy of modern statesmanship is caused by the misconceptions about politics. Here, Professor Morgenthau has probably overdrawn his argument. The entire book is, nevertheless, an excellent attack upon the usual methods of thinking about international relations.

Unfortunately, certain terms in the book deceive the reader. The "scientific man" envisaged from the book's title is not the physical scientist, as one would at first surmise, but the general type of thinking which lists supposed facts in an effort to find single causes and simple solutions. In other words, the term "scientific man" incorporates men in the social sciences who feel that they are employing the methods of the physical sciences in the social fields.

The first half of the book is devoted to the development of this type of thinking in political science. The author takes for granted the reader's acquaintance with political theory. For example: a reference is made without any introduction to the ideas expressed by Thrasymachus, one of Socrates' pupils and foils in Plato's "Republic." This manner of writing discourages the general reader who does not have the "saints" of political theory clearly in mind.

The second half of the book, however, comes to grips with the problem of misconceptions in political thought and deserves careful reading. The differences between thinking in the physical sciences and the social sciences are brought out very clearly and in a highly interesting manner.

The best general method of attacking this book is to skip lightly through the first half, reading enough to understand the development of the thesis and the background of scientific thinking in the social sciences. Then read the second half of the book in detail.

After finishing, some readers will continue to search for *certainty* and find frustration. Some will give up the search but will think and write on a broad basis which will gather facts, accept the irrationality of man as a fact, permit flexibility of planning for the struggle for power, and admit the possibility of complexity and confusion. Some will abandon the search, plunge into domestic politics, and fight for their interests. Others may give up in despair, forecast the doom of western civilization, and revel in the works of Gibbon, Spengler, and Toynbee. Still others may cut their own throats.

[2] "Scientific Man Vs. Power Politics," by Hans J. Morgenthau, Chicago, 1946.

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## European Repayment Plan

LEADERS of Detroit's major industries have before them a strong recommendation that nations receiving assistance under the European Recovery Program be required to repay the United States in raw materials urgently needed for the national emergency stockpile.

The proposal was made on February 18, 1948, by William L. Batt, Honorary Member and past-president ASME, president of SKF Industries, Inc., before the Engineering Society of Detroit.

He told executives and production experts that the United States would be at a "desperate disadvantage" in the event of a war within the next few years because it lacks many essential raw materials such as tin, manganese, and bauxite, the familiar base for aluminum.

These and other materials are abundant in the 16 co-operating European nations and their colonies.

He stated that we must insist, in our agreements with these countries, upon this form of repayment to the maximum of each nation's ability. As long as peace is not a reality, we must be prepared for the awful business of war. No opportunity should be overlooked to repair this weakness in the shortest possible time and in amounts as large as practicable.

He said the United States is "slowly but surely passing from a nation of plenty to one of scarcity in many of its essential material resources" and he declared that it has now become painfully clear—and it will come as a shock to many of our people—that the abnormal demands of two wars, plus our own heavy consumption and some wastefulness over the last half-century, have taken an irreplaceable toll.

Mr. Batt, now a member of the Government's Advisory Committee on Voluntary Foreign Aid, called upon industry to lend engineers and production experts to the recovery program for duty here and abroad. Much more can be done through firsthand participation, he added, than "merely through our dollars."

American engineers can do more than any one group to modernize and restore the productive capacity of Western Europe and once again send thick black smoke pouring from factory chimneys, he said.

# BRIEFING THE RECORD

## Abstracts and Comments Based on Current Periodicals and Events

Compiled and Edited by J. J. Jaklitsch, Jr.

MATERIAL for these pages is assembled from numerous sources and aims to cover a broad range of subject matter. While few quotation marks are used, passages that are directly quoted are obvious from the context and credit to original sources is given.

## In-Service Education

THE shortage of scientists and engineers is so acute owing to war interruptions of education that if America is to play its world role, industry must pool its training resources with those of the engineering colleges, Dr. Edwin S. Burdell, Director of The Cooper Union, New York, N. Y., announced recently. The conventional four-year course followed by two or three years of apprenticeship in industry must give way to an in-service educational program that in effect speeds up by coalescing both aspects of the preparation of training men for industry.

According to Dr. Burdell, industry can be saved this waiting period and young men can be gainfully employed if suitable arrangements are perfected by which those in industry with aptitude for engineering may be educated in the engineering colleges at the same time they continue their work in industry.

To meet the shortage of engineers through this type of evening education, Dr. Burdell announced that The Cooper Union is activating a Division of Industrial Relations to be headed by Prof. Herbert F. Roemmele, member ASME, a member of the department of mechanical engineering at The Cooper Union.

Going to school in the daytime and studying at night is not unique in urban areas, nor are certain forms of co-operative engineering courses in which students alternate, in three to six-month periods, classroom work with tours of duty in industry. What is unique is an integrated in-service training leading to engineering degrees in six to seven years, whereby evening students are employed in those industries in which the day employment has a direct bearing on the educational program. The advantages accrue not only to industry but to young men who may have acquired family obligations which necessitate daytime employment. "To earn while they learn" is an opportunity sought by many ambitious young men.

The Division of Industrial Relations is to see to it that every student enrolled in the evening courses has the opportunity for suitable employment in industry, and conversely that industries which have promising young men with engineering aptitude have an opportunity to have these men train at no cost to them or to the student in the evening engineering classes.

This plan for co-operative and simultaneous training by both engineering concerns and the Engineering School in reality benefits management as much as it does the students, Dr. Burdell said. It assures industry of doubly trained employees, who are worthy of upgrading because they have supplemented the "how" of practice with the "why" of theory. In addition it provides the student with an employment record as well as a degree upon graduation.

## Artifical-Limb Research

THE recently published report of the Committee on Artificial Limbs of the National Research Council, entitled "Terminal Research Reports on Artificial Limbs," covering the period from April, 1945, through June, 1947, reveals an interesting account of this research effort and its results.

It is estimated that the total number of amputees in our population is about 500,000, most of whom require artificial limbs. The annual rate at which new amputees are added to the existing number is estimated at 40,000. Thus it is readily seen that such a problem is of great interest to a large segment of the population.

According to the report, after a great deal of preliminary work and preparation, several lines of attack were followed using mechanical, hydraulic, and electrical means for force transmission in the development of an artificial hand. Improved mechanical arms using shoulder harnesses to actuate the hook or hand and to flex the elbow were designed, constructed, and service-tested, and now are available commercially. A functional mechanical work arm with a doubly wrapped spring elbow lock was evolved which was adapted to use many tools. In the application of hydraulics one hand was developed using ankle flexion for its motive power, while a hydraulic control unit to actuate hooks and hands is in the process of being completed. An electrically operated hand, to which the energy is supplied by miniature storage batteries carried around the amputee's waist, holds in prospect ease of control and mobility, particularly for shoulder disarticulation cases. The cineplastic artificial hand, which operates from pegs inserted through surgically constructed skin-lined muscle tunnels in the arm, or in the greater pectoral muscle, has given promise of materially improved function in hand prostheses for certain cases. Some improvement has been made in the arm and hand field by the use of force multipliers which have enabled the amputee to exert a stronger finger grasp than was possible previously.

Hand coverings, used to protect the complicated internal mechanisms of the hand, as well as to provide a natural appearance, have been improved and the new "cosmetic" gloves defy detection when casually seen beside a normal hand. Some research has been done also in an attempt to recover partially the sense of touch in the artificial hand, but so far this venture has not been completely successful. A major advance has been made in the construction of the artificial forearm and socket by the use of modern plastics and improved fitting methods. Standardization of certain mechanical parts of the arm, such as the wrist disconnect, should lead ultimately to simplified manufacturing procedures and reduced costs. Although much work has been done in the field of arm harnesses and suspensions, the final and most efficient design probably has not been reached.

In the field of lower extremity prostheses, extensive and exhaustive studies were made of the motions and actions of normal and artificial legs, ankles, and feet. Human locomotion

and the mechanics of walking were investigated through the use of high-speed motion pictures of x-ray shadowgraphs of normal subjects, as well as through high-speed photographs of normal and amputated subjects to whose joints small light bulbs over the centers of rotation of the joints of the leg were attached. The field of view of the camera was interrupted at short-time intervals so that the displacement patterns on the film of the camera appeared to be small lights moving along the path of each joint and flashing at short equal time intervals. Measurements of force were made in various parts of the artificial legs, and the force with which the normal foot reacts with the ground was measured. From these data instantaneous centers of pressure of the normal person and of the amputee were computed accurately and improved leg designs were approached. The dissection of the human ankle revealed useful information as did the development and study of an artificial adjustable leg. As in the study of the hand, a review was made of existing literature, patents, and models, and anthropometric measurements were made on many subjects. Electromyographic studies were made of muscle actions in the leg, and an investigation is under way to seek the causes of deep-seated pain in the stump.

From the fundamental studies of lower extremities, it was learned that one outstanding prerequisite for a normally acting artificial leg was the construction of a knee lock which would automatically lock or disengage at two distinct points in the walking cycle. Mechanical knee locks were demonstrated which were actuated by foot controls or by placing the amputee's weight on the stump socket. Hydraulic knee lock mechanisms, however, seemed to exhibit more practicality and there is evidence that a hydraulic knee lock which allows the artificial leg to approach closely the cadence and rhythm of the normal leg will be service-tested soon.

Two artificial shanks, which showed significant improvement, were developed under Committee auspices. One was of crustacean-type construction, fabricated out of a Fiberglas laminate impregnated with a low-pressure resin. This design has withstood satisfactorily all service and accelerated tests thus far. The other shank consisted of a Fiberglas laminate cylindrical tube impregnated with a modified phenolic resin and surrounded by a lightweight cellular cellulose acetate covering which duplicated the contour of the normal leg and was covered by a rubberlike material which looked and felt about like the natural flesh.

Two rubber ankle mechanisms have been constructed, each of which reproduced the normal ankle action with reasonable faithfulness and protected the artificial leg and the amputee from shock by a cushioning action. As a result of the ankle dissection studies, an experimental, adjustable mechanism which permitted limited rotation about the artificial shank was designed and constructed. By the use of this ankle rotation mechanism, improvement in the subject's gait was observed and the amputee reported immediate improvement and comfort due to a marked reduction of irritation and pain at the ischial seat.

One of the most significant developments in the artificial leg field has been the reintroduction in this country of the method of securing the limb to an above-knee stump by suction or atmospheric pressure. It is referred to as the "suction socket." This has eliminated the necessity for wearing cumbersome harnesses and belts and has given the amputee a greater feeling of security. Although the service tests on this method of fitting have not been completed, indications are that the suction-socket method of fitting will be a vast improvement for above-knee amputees with suitable stumps.

A new mechanical method for fitting sockets has been investigated, which, although thus far has been applied satisfactorily only to below-knee stumps, shows promise in the fitting of above-knee amputees as well. This system, based on the "dilatancy" principle, consists of molding a positive replica of the stump in a negative mold, the latter formed by pouring small glass particles around the stump and then solidifying the mass by removing the air surrounding the glass beads. From this positive replica the socket is formed.

A program of mechanical tests, laboratory tests, and service tests has been undertaken by the Committee. Several leg testing machines and hand and arm testing machines have been developed and put to use. Also, standards have been established covering the field of plastics for the artificial limb industry. This comprehensive program of testing has aided greatly in expediting final approval by the Committee of developed products in order that these devices might be manufactured commercially and made available to the public.

# Photographic Finishes

PHOTOGRAPHIC prints are now ready to blossom forth on textiles, pottery, and glassware, according to the *Industrial Bulletin* of Arthur D. Little, Inc., December, 1947. Recent developments make it possible to print fabrics continuously with designs obtained from photographic negatives. Chinaware, too, is treated with a photosensitive material which is developed during the firing. Another new process makes colorless glass photosensitive throughout its body, and development of the image takes place when the glass is reheated.

Although the principle of printing photographs on textiles has been known for some time, until now there has been no practical method adapted to continuous operation. This, with a lack of proper dyes and finishing agents, made photographs on fabrics slow and costly, and the results did not appeal to fashion designers. Recently, two processes have been developed for commercial operation: one is the Leize process of Foto-Fab, Inc., and the other is called "Phototone" by Ross-Smith Corporation. It is estimated that about six million yards of textiles will be printed this year for dresses, scarves, draperies, and ties. Material thus printed is expected to be used in theatrical backdrops and window displays as well as in clothing accessories embellished with pictures of favorite movie stars.

Both processes are intricate and require close control by chemists and photographers. The fabric is treated like photographic paper; it is sensitized to light, then brought into contact with a transparent film. Light shining through the film prints the design on the fabric. With the Phototone process, which may be used on acetate rayon as well as other fabrics, the dye on the material is partially destroyed to achieve the photograph, while the Foto-Fab method develops the color to make the print. It is claimed that a third-dimensional effect is achieved and that in many cases the fabric has an improved "hand." The colors are as washable as the fabric itself and are fast to dry-cleaning solvents. The prints are in shades of various single colors; multiple colors are not yet possible, although the sponsors of both processes foresee them for the future.

Since the photographic printing process is not as rapid as ordinary roller or screen printing, the cost of printing and treating the fabrics is considerably higher than with conventional methods. The sponsors expect, however, that by the time multiple-color combinations are possible, the process will be competitive with regular printing methods. Other textile technologists feel now that it will be limited to specialty items and will not displace standard textile printing.

To achieve photographic effects on ceramics, the Onondaga

Pottery Company has developed a method for sensitizing its chinaware before it is glazed. The design is transferred from the film to a sensitized coating on the chinaware, then the glaze is applied, and the piece is fired. The heat of the kiln completes the development of the finished color in the design, which is permanent.

The new Corning glass does not involve a sensitized coating, but full-tone reproduction of ordinary photographic negatives is possible because the photosensitive material is incorporated into the glass itself, which is formed into the desired shape by conventional glassmaking methods. Since the glasses are not sensitive to visible light, they may be handled in room light; exposure is made with strong short-wave irradiation, such as under the mercury arc. The design is then developed by reheating the glass to a temperature near the annealing point which brings out the color. The color depends on composition of the glass, exposure time, and developing time; concentrations of coloring metals, glass composition, and furnace atmosphere are chosen to produce a colorless product when the glass is melted and cooled in the ordinary manner. Irradiation with short-wave light causes clustering of the color-producing metals to form colloidal particles where color is desired. The "grain" of pictures developed in this manner is much finer than in ordinary photographic processes. It is expected to be used for labeling, trade-marking, instrument panels, permanent microfilm records, and lantern slides, as well as for decoration or portrait and scenic photographs.

## Canadian Hydroelectric Progress

DURING 1947, the demand for hydroelectric energy has expanded in practically all districts of Canada at an unanticipated high rate and has refuted a widely held expectation that a decline in power consumption would eventuate in early postwar years. The greater part of this power demand resulted from a high level of industrial activity in the manufacturing centers of the country; in addition, commercial and domestic loads have been growing rapidly because the lifting of restrictions on the use of power and to the increased use of electrical applicances which again have become available for purchase. Also, although somewhat curtailed by material and labor shortages, there have been large extensions to rural service, as the generally prosperous condition of agricultural districts has intensified the demand for farm electrification. For the first ten months of 1947, the total electrical output of central electric stations in Canada, as reported by the Dominion Bureau of Statistics, was nearly 10 per cent higher than that for the same period of the previously high year of 1946, and was more than 12 per cent in excess of that recorded in 1944, the war year of greatest production. The consumption of primary power, which is a measure of peak-load demand, also recorded a new high level exceeding that of the year 1944 by more than four per cent and being nearly 90 per cent above that of the prewar year 1939. This growth in primary demand points to an imminent shortage of primary power, especially during the peak-load winter period, pending the completion of new plants now under construction or planned. In Ontario, late in the year, some restrictions on the use of power were reimposed on commercial and industrial users for the critical winter months; also, extended drought conditions in New Brunswick and Nova Scotia in the late summer and autumn, curtailed production and required restrictive measures.

During the war years, a total of 2,000,000 hp was added to the hydraulic generating capacity of the country and this was expected to provide a tentative reserve of power for immediate postwar years. Hence little new construction was undertaken during 1945 and 1946 and, as considerable time is required to complete a major hydroelectric project, only 178,800 hp of new capacity was brought into operation during 1947, a considerably lower figure than the 300,000 hp average yearly prewar rate of increase. The present great demand for electricity therefore has resulted in an unprecedented program of expansion in the hydroelectric field, there being plants at present under active construction which will have a total capacity of more than 1,000,000 hp of which more than 500,000 hp is expected to be brought into operation during 1948. Additional sites which are under preliminary investigation for more long-range planning also total about 1,000,000 hp.

## Motor-Mount Testing Machine

A MOTOR-MOUNT testing machine, designed and built for the purpose of providing an adequate and convenient means of determining the rate, hysteresis, and life expectancy of automobile motor mounts, was described by Lloyd E. Muller, staff engineer, Buick Motor Division, General Motors Corporation, Flint, Mich., at the 1947 ASME Semi-Annual Meeting held in Chicago, Ill.

A practical method of damping the engine's amplitude of motion became available with the commercial production of synthetic rubber of the high hysteresis type. However, this new factor presented the problem of measurement and control. It was with this desire in mind that the Buick Motor Mount test machine shown in Fig. 1 was developed. The two factors which control vibration can now be evaluated as this machine will record the hysteresis and rate of an actual mount under dynamic conditions. Basically, the machine is composed of a mechanical stroker, an electronic strain recorder, and a photographic recorder.

Fig. 2 is a close-up view of the mechanical stroker. The mount undergoing test is located at *A* and is held by bracket *B* which is bolted to plate *C*. This plate can be adjusted to give the desired preload on the mount or test sample. Movement of the mount in either shear or compression and tension loading is actuated through the reciprocating rod *D* by means of the crank at *E*. The machine is belt-driven by motor *F*. Loads applied to the mount are measured by means of SR 4 strain gages cemented to load-recording tube *G*. The corresponding stroke is obtained by strain gages on stroke-recording tube *H*.

The heating box is equipped with a heating element, automatic temperature control, and electric fan. The inside of the box is lined with asbestos. Endurance tests are made at 100 F inside the box at a point one inch from the mount being tested. This temperature can usually be maintained within ± 5 F with-

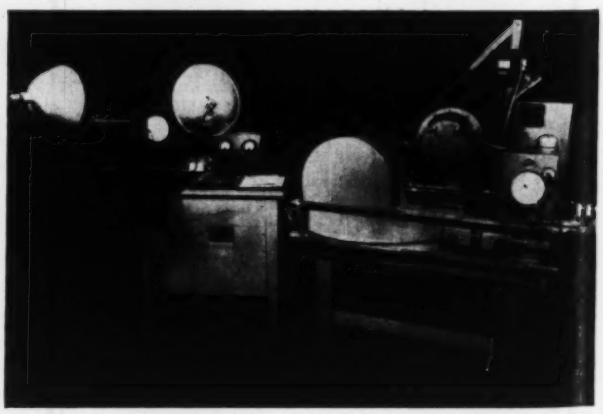


FIG. 1 MOTOR-MOUNT TESTING MACHINE

FIG. 2 CLOSE-UP OF MECHANICAL STROKER

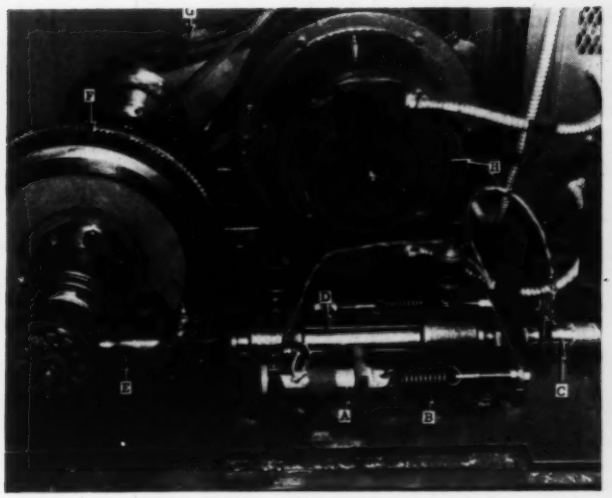



FIG. 3 STROKE-RECORDING MECHANISM

out applying heat. When higher temperatures are required the automatic temperature control is set for the desired temperature and a bimetal thermostat regulates the temperature in the box through the heating element. In order to maintain uniform air temperature surrounding the mount the fan is operated on all tests. A shield is used to prevent heat or other rays from the heating element striking the rubber in the mount.

Four strain gages connected in series are cemented to the load-recording tube. This tube is made of steel and has a very thin wall. For a test having low loads, a tube of 0.040-sq-in. cross-sectional area is used. To secure accurate data all tubes are made from a steel of known modulus of elasticity.

Four Baldwin-Southwark strain gages are used to eliminate possibility of errors from slight bending that might occur because of uneven loading, particularly when a mount starts to fail on one side. When the tube is subjected to compression and tension loading, the fine wire, of approximately 0.001 in. in diameter, in the strain gage is elongated with tension loads which raises its resistance and is shortened with compression loads which lower its resistance. This change in resistance is proportional to the load imposed on the tube by the engine mount.

Assurance that strain gages are operating properly is quickly attained by means of a calibrating spring of known rate which is installed in place of the mount. This spring, which has a rate of 1050 lb per in., is equipped with plug ends designed especially for installation on this machine. As the spring rate is known, calculations from the strain-gage data readily determine the accuracy of the strain-gage readings. The actual stroke is measured by an indicator on the spring side of the load-recording tube.

Whenever a strain gage or tube is replaced a static test is made. The static test is made by applying known loads to the tube in either compression or tension and the use of a Wheatstone Bridge to obtain the change in resistance of the strain gages. If the strain gages and tube are operating properly the calculated and applied loads will be equal. If there is a discrepancy, further checks must be made by testing each strain gage separately. With this method the faulty gage can be quickly detected.

Fig. 3 shows the stroke-recording tube *A* and operating mechanism. A spring is introduced between the tube and the drive rod as the tube will not stretch as much as the stroke imposed on the mount. Spring *B* is of a known rate. The stroke-recording tube is similar to the load-recording tube *C* except that it is necessary to have a slightly thinner wall section or a very high spring rate in order to give a satisfactory signal on the oscillograph. The reciprocating shaft *D* is driven through connecting rod *E*. To maintain uniform angular velocity throughout the operating cycle a heavy flywheel *E* is mounted on the crankshaft. Wires connect the strain gages to the amplifier. A variable stroke is obtained by means of an eccentric located inside the large end of the connecting rod *E*.

The load and hysteresis loop obtained through the strain gages is shown on an oscillograph which is connected to an amplifier. A power unit is used to supply current for the amplifier. In order to obtain the correct load readings it is necessary to calibrate for various settings of the oscillograph controls by means of breaker points operated by an electric motor.

Three types of dynamic tests are made on the testing machine, constant-speed tests, constant-temperature tests, and endurance tests. The endurance tests are run at constant speed of 750 cpm and constant air temperature of 100 F. The three types of tests can be made for both tension—compression and shear loading. Static tests can be made by measuring the applied load with a Wheatstone Bridge connected to the strain gages and the deflection with an indicator.

In order to obtain a permanent record and to assist in making calculations of rate and efficiency, life-size photographs of the oscillograph image are made for each test. Four exposures are required to show the vertical and horizontal axis, the hysteresis loop, and the calibration dots.

The results of tests that have been made on the machine thus far can be used only as a rough guide, since the tests were run on compounds furnished by various rubber companies. The rate, modulus, or efficiency might vary from one company to another for the same durometer hardness.

## Spectroradiometer

THE Spectroradiometer is an instrument recently developed at the Lancaster plant of the RCA tube department of the Radio Corporation of America and it is described in *Electrical Engineering*, January, 1948. It is used to measure such optical properties of luminescent materials as color, visual efficiency, peak energy, build-up and decay of fluorescence and phosphorescence under continuous and discontinuous excitation, flicker,

stability, photoconductivity, and infrared quench and stimulation effects.

It uses a special cathode-ray tube which consists of a demountable vacuum chamber and a standard electron gun. Samples of luminescent materials to be tested are placed inside the chamber on a glass disk which may be rotated to pass each sample under the beam of electrons coming from the gun. Electrons strike and excite the luminescent material and the emitted light is reflected by a mirror into a spectroscope where a prism disperses the light into the various wave lengths of its spectrum. A motor turns the prism slowly, causing small portions of this spectrum to fall in sequence on a photoelectric tube which produces an electric signal proportional to the amount of light at each wave length.

After being amplified the signal is applied to the vertical deflection circuit of a 12-in. cathode-ray tube oscillograph. The horizontal deflection provides the wave-length scale which is produced by a potentiometer coupled to the motor shaft that turns the prism. The combination of vertical deflection indicating relative energy plus horizontal deflection giving wave length gives a "picture" of the spectral energy distribution of the luminescent material being measured.

The long-persistent screen of the cathode-ray tube permits as many as four separate curves to be compared simultaneously. A number of horizontal slow sweeps, provided by motor-driven potentiometers, permit build-up and decay measurements. In addition, a solenoid-operated shutter on a blue light source can be set to apply pulses of light to samples of luminescent material by manual or automatic control, cleverly duplicating the performance of double-layer radar screens.

# Reports From Germany

## *Powder Metallurgy*

A REPORT (PB 39354r) on German wartime advances in the field of powder metallurgy, for sale by the Office of Technical Services, Department of Commerce, Washington 25, D. C., includes information on the preparation of metal powders and the manufacture of powder-metal parts and hard sintered carbides by the hot-press method. Composition and uses of carbides for projectile cores and cutting tools are described.

According to the report, the Germans relied entirely on the hot-press method, while American industry pressed cold and sintered as a separate step.

The outstanding war development in the German hard cemented-carbide industry appears to have been the standardization of compositions and methods of manufacture, the report states. A number of new steps pertaining to fabrication processes are also reported. The hot-press, used in the production of cores for armor-piercing projectiles and in the development of tungsten-free cutting materials, is believed the most outstanding innovation.

The Germans surmounted the difficulties usually associated with the simultaneous application of great heat and pressure (that of loss of the molten binder by extrusion) by using carefully weighted prepressed charges with a constant apparent density to control the final volume. The methods developed are described in the report.

The German hot-press is of the graphite-resistance type, the spring-clamped mold being the resistor with a separate mechanical or hydraulic system available for applying the top and bottom plunger pressure. A corps of electrical, mechanical, and metallurgical engineers worked on the development of the hot-press process and successfully designed an ingenious series of auxiliary machines for the mass production of mold, plunger, and separator forms. The result is a system of hot-pressing rather than an improvement of the hot-press as a unit device, the report points out.

It is reported that a rotating-disk method was universally used for disintegrating all kinds of molten metals, alloys, or even emulsions of nonalloying metals.

The disintegration method is simple: The molten metal, superheated in the case of metals of high melting point, flows through a funnel crucible having a nozzle 7 to 9 mm in diameter and strikes a disk, rotating at high speed, on which knives are mounted. The molten stream is enclosed by a water cone which is formed by a ring nozzle fixed below the outlet of the nozzle of the funnel crucible.

The size and shape of the particles is changed by varying the rotation speed from 2000 to 6000 rpm and regulating the water nozzle. The powder, washed into a container by the water employed in the operation, forms a slime which is dried. The resulting powder produced has a particle size of about 0.6 mm.

Copper, silver, and aluminum powders as well as a number of different powders for research were produced by the rotating-disk method.

Production of metal powders by pressure atomization with steam is also described.

## *Torsion-Bar Suspensions*

Wartime production techniques for torsion-bar suspensions were high caliber and incorporated several novel features, according to a British report (PB-18943) on the German spring-making industry, also on sale by the Office of Technical Services, Washington, D. C. Torsion-bar suspensions were used in most types of German armored vehicles and in many civilian wheeled vehicles.

Basic electric or good quality open-hearth steel was used in the manufacturing process throughout, the report states. For armored-vehicle torsion-bar suspensions a chromium-vanadium steel of the following composition (in percentages) was used: carbon, 0.5–0.6; silicon, 0.4 maximum; manganese, 0.8–1.0; sulphur, 0.003 maximum; phosphorous, 0.03; chromium, 0.9–1.2; and vanadium, 0.15. Particular attention was paid to furnace atmosphere by adjusting fuel-air ratios to avoid the damaging effect of surface oxidation or decarburization.

Among the novel torsion-bar suspension-production techniques noted are the use of roller peening to induce surface compressional stresses and oscillating centerless grinding of the torsional length of the bar after heat-treating. All firms visited employed a 100 per cent test in which the bars were twisted in torsion, both ways, to a predetermined stress within the elastic range, the requirement being that the bars should return to within one per cent of the original position at the completion of the test.

The manufacture of scroll-type springs, including clock and watch mainsprings and hairsprings, is also a highly developed specialty in Germany, according to the report. High-quality materials are used and the products are finished to great accuracy by highly trained labor. It would be useless to imitate German techniques unless materials as good as those used in Germany were available, the report states.

## *Synthesis-Gas Manufacture*

Brown coal was successfully gasified in Germany by the Wintershall-Schmalfeldt process to yield a gas suitable for Fischer-Tropsch synthesis, according to a British report (PB-78242) on sale by the Office of Technical Services, Washington

25, D. C. The Wintershall-Schmalfeldt process is to a large extent an alternative to the customary Winkler generator process for manufacturing synthesis gas from brown coal.

The report describes the operations of a plant for the manufacture of synthesis gas by the process at Lutzkendorf.

The plant was built in 1938 and was intended originally to operate for Fischer-Tropsch synthesis only. Later a hydrogenation plant was added, hydrogenating natural oil and bituminous coal tar. The process consists essentially of gasification of dry brown coal dust in the entrained state; the heat of reaction is aided by burning producer gas, storing heat in a regenerator, and then abstracting it by recirculating saturated synthesis gas and oxygen. Sensible heat in the final gases is used to dry and disintegrate the dry brown coal. The producer gas is made by gasifying dry brown coal dust in the entrained state, using air with a little steam.

## *Centrifugal Stowing Machine*

Operation and use of a novel slinging stowing machine employed to throw and pack waste material into mined-out sections of coal mines in the Ruhr district of Germany is described in a British report (PB-80410) on sale by the Office of Technical Services, Washington, D. C. It is reported that stowing with the machine called the "Kreiselshleuder" (centrifugal slinger), is cheaper than pneumatic stowing. The stower has a peak capacity of 105 cu yd per hr, compared with the 90 cu yd with the largest-type penumatic machine.

All the machines seen were driven electrically but it was stated that machines are in use which have a compressed-air drive. One mining engineer stated that 13 of the centrifugal slingers are in use in the Ruhr coal field. The machines can handle crushed pit dirt, crushed screen dirt, washery dirt, boiler ashes and flue dust, and sand and gravel.

At the Friedrich Heinrich mine near Mors a modified Kreiselshleuder of large capacity which could work in the low 4-ft thick "Albert" seam was found. The machine, which weighs approximately one ton, is designed to sit astride a trough face belt and runs on removable rails between the conveyer frames. The slinging belt is at right angles to the face belt, and the driving pulley on the waste side has an 8-hp motor built into it. The feeder belt is 26 in. wide, the stowing belt 23 in. The stowing material is scraped off the face belt into a semicircular hopper by a curved scraper and fed to the stowing belt which runs at 2165 fpm and throws a horizontal distance of about 10 ft. Depression rollers which give the centrifugal effect are mounted on roller bearings and stub axles. The machine is said to be capable of stowing 165 cu yd per hr, but in practice a figure of 120 cu yd per hr is rarely exceeded, the report states.

## *Acetylene Production*

Production of acetylene from methane in a German-designed regenerative-type furnace is described in a report (PB-80331) on sale by the Office of Technical Services, Washington, D. C.

The report contains information on a process worked out in Germany which utilizes methane as a raw material.

The process, in brief, follows: The feed gas methane is passed through a regenerative-type furnace previously heated by combustion of methane. The true gas velocity is 100 meters per sec and the reaction time, 0.01 sec. Pressure is reduced to 0.1 atm. Intermittent heating and reaction periods are of one minute duration each. Immediately after passage through the furnace the gas is quenched by water sprays to stop further decomposition.

The gas enters the bottom of the preliminary scrubber where carbon dust is washed out and the gas is further cooled. The water effluent from this scrubber is subsequently processed after clarification in the diacetylene and acetylene scrubbers in order to recover dissolved acetylene. From the preliminary scrubber the reaction gas passes through three Raschig ring-packed cooling towers arranged in series in which the gas is still further cooled by countercurrent water flow to a temperature of about 25 C. The washed, cooled, and moist gas then enters a vacuum pump in which it is compressed to atmospheric pressure and pumped to a crude reaction-gas gasometer.

From the gasometer the crude gas is pumped into scrubbers for the removal of diacetylene. The off gas, free of diacetylene, is scrubbed with a large amount of water in the acetylene scrubber at a pressure of 11 atm. The scrubbed gas which carries the bulk of the acetylene, carbon dioxide, and some hydrogen and methane in solution, is expanded through a turbine into the top of the hydrogen-methane stripper to a pressure of 1.0 atm abs. Hydrogen and methane are almost entirely removed by blowing pure acetylene into the bottom of the stripper.

The bulk of the acetylene, which together with carbon dioxide is dissolved in the water effluent of the hydrogen-methane stripper, is now expanded into two acetylene degassers and acetylene and carbon dioxide stripped from the solution. The moist gas is compressed to atmospheric pressure, carbon dioxide scrubbed out in a scrubbing system with potassium carbonate solution, and the acetylene product gas is collected with a gasometer.

# Silicone Golf-Ball Center

SILICONE and a new electronic thread-winding device will be used in the production of a new golf ball, it was announced recently by United States Rubber Company.

The silicone—new elastic substance derived from sand—will be put into the center of the ball to give it improved distance, "click," and "feel.". The electronic device, equipped with an electric eye, will control the tension of the thread wound around the center, making all balls uniform in playing performance.

The so-called silicone "bouncing putty" is said to have more resilience than any other substance ever used in a golf-ball center. In its crude state it resembles soft putty.

Tests conducted by professional golfers and scientists are said to demonstrate that the new ball gives more distance than any other ball. In addition to longer flight it is claimed to have improved click and feel.

Development of electronic winding tension control will make it possible to produce thousands of golf balls possessing the same degree of resilience.

The winding device consists of a photoelectric tube wired up to a complicated system of relays, amplifiers, and other apparatus. A narrow beam of light shines from a small bulb through a lens onto the photoelectric tube. The golf-ball thread is in the path of the light, vibrating like the string of a violin. Thus the beam of light is interrupted when the vibrating thread crosses its path, transmitting impulses of light to the phototube. The tube is adjusted to take the impulses at a preset, uniform frequency. When they come too fast or too slow an electronic brake applies more or less pressure on the thread, bringing it back into "tune." This checking and adjusting automatically takes place in a fraction of a second, thus keeping the tension virtually constant throughout the winding process.

Tension control has been an important factor in golf-ball manufacture since rubber thread was first used 48 years ago. Variations in tension are caused by differences in the thickness and elasticity of the thread. These variations are often so

slight that they cannot be seen with the naked eye, yet they are immediately detected by the electric eye.

Historical facts reveal that golf was first played in Scotland more than 500 years ago. The first ball was made of leather stuffed full of feathers. The leather was cut into three pieces, softened, and then sewed together with a hole left for putting in the feathers. The feathers were then stuffed into the cover with an iron tool and the hole sewed up.

The United States Golf Association requires that the present-day golf ball must be not less than 1.68 in. in diameter and weigh not more than 1.62 oz.

The silicone center in the new U. S. Royal golf ball is about the size of a large pea. This center is under constant pressure of about 2500 psi.

The top-grade ball contains about 30 yards of high-quality rubber thread. This thread is stretched about eight times its original length. The potential energy stored up in the thread is sufficient to raise a 310-lb man a distance of one foot.

The chief function of the cover is to provide a tough protective coating over the thread. The covers are "dimpled" to improve their aerodynamic qualities. A smooth ball falls to the ground after 85 to 125 yd of flight. Properly designed dimples extend this distance to 225 yd or more and also keep the flight straight and true. A variation of 0.001 in. in the dimples can materially affect the flight of the ball.

A ball, when struck by a club, is in contact with the club head only about 0.0004 sec, during which time sufficient energy is released to start the ball off at the rate of approximately 125 mph. The average rate of speed of a golf ball over its entire flight upward of 200 yd is around 85 mph.

## Upper-Atmosphere Flight

THE high speed associated with flight at very high altitudes introduces many new problems to the aircraft designer, according to a paper presented by J. R. Stalder and D. Jukoff, junior ASME, Ames Aeronautical Laboratory, Moffett Field, Calif., at a joint meeting of the Institute of the Aeronautical Sciences and the American Physical Society, in New York, N. Y., recently. One of the more important problems is due to overheating of the aircraft or missile because of air friction. The severity of the problem is shown by the melting and combustion of meteorites that enter the earth's atmosphere at high speeds.

At the extreme altitude encountered during flight of sounding rockets or missiles, the atmosphere can no longer be considered as a continuous medium, and account must be taken of the motions of the molecules comprising the atmosphere.

Using the methods of kinetic theory, calculations have been made of the temperature of bodies traveling at high speed in the upper atmosphere. The calculations cover a range of altitudes of from 75 to 150 miles and a range of speeds up to 13,000 mph.

It is shown that, under all flight conditions above 75 miles, to alleviate the frictional heating problem, body angles should be kept as small as possible. This implies the use of slender bodies with long, pointed nose sections. It is also shown that for negative body angles with respect to the flight path, i.e., on the boat-tailed section of the body, the skin temperatures are very much lower than on the nose section, and above a certain speed, the faster the missile is flown, the cooler the boat-tailed section becomes. This immediately suggests the use of an internal cooling system connecting the forward and rear portions of the body.

It is shown that at 75 miles' altitude, the presence of solar radiation has little effect upon the body temperatures at the highest flight speed calculated. The effect of solar radiation would be expected to be more important at the lower flight speeds. On the other hand, at altitudes of 150 miles, solar radiation is the predominating factor that determines the body temperature at all flight speeds.

## Wind Tunnels

TODAY wind tunnels are by no means used only in research establishments and their application is not even confined to the aircraft industry, according to an article in the January-March, 1947, issue of *The Brown Boveri Review*. Industries which appear to have nothing to do with aerodynamics purchase wind tunnels for their investigations. For example, Brown Boveri supplied a small wind tunnel to a manufacturer of fittings to measure the flow resistance of the fittings and in particular to develop good aerodynamic forms. The wind tunnel is specially suitable for such experiments since it is much more convenient and quicker and cleaner to work with air instead of water. The interpretation of the results obtained with air for the appropriate water or fluid conditions follows easily with the help of modern theories of similitude. Proof that industry is taking greater advantage of these possibilities is furnished by the fact that the company has already obtained a second order for a small wind tunnel for similar purposes.

Aerodynamic institutions are specifying ever-increasing cross sections in order to investigate full-scale aircraft. A further problem is provided by the effect of the compressibility of air which becomes more important the nearer the speed approaches the velocity of sound. So-called high-speed wind tunnels are used for investigations in this region. The power required to obtain the velocity of sound in the necessarily large section has already reached 100,000 kw and more.

Investigations in connection with rocket aircraft and projectiles, as well as in the sphere of ballistics, call for ever-increasing velocities. Greater and greater cross sections are required as the Reynold's number has been found to have a considerable effect even at supersonic speeds.

One of the company's licensees received an order during the past year for a complete supersonic wind tunnel for high Mach numbers up to 4. Fig. 4 shows a schematic diagram of this supersonic wind tunnel which has a driving power of 13,000 kw.

It is reported that only one other plant exists in which such a high Mach number can be attained, and that is here in the United States.

During the past year, too, the company has extended its own

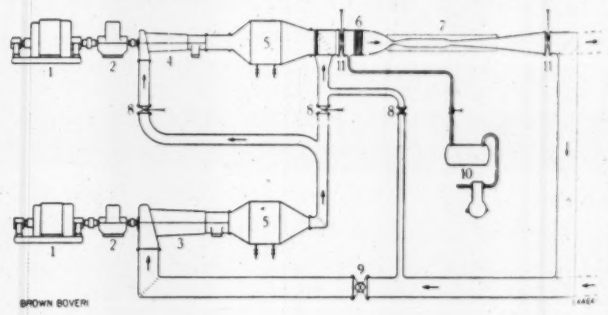



FIG. 4 DIAGRAM OF A SUPERSONIC WIND TUNNEL FOR A MACH NUMBER OF 4

[(1) Motor, (2) gearing, (3) low-pressure compressor, (4) high-pressure compressor, (5) cooler, (6) stabilizing filter, (7) test length, (8) stop valve, (9) regulating valve, (10) dry air accumulator with compressor, (11) stop valve.]

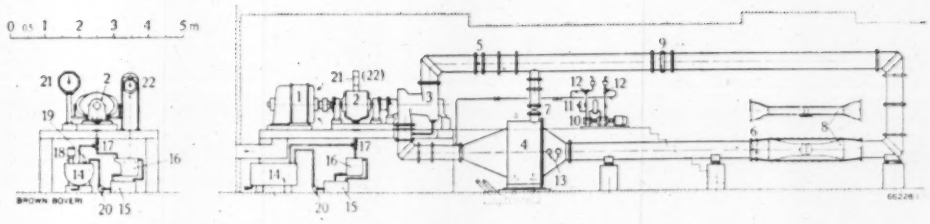


FIG. 5 DIAGRAM OF BROWN BOVERI SUPERSONIC WIND TUNNEL

[(1) DC motor rated 750 kw, 1500 rpm, (2) two-stage cradle gearing 1500/11,200 rpm, (3) axial blower 5.2 cu m per sec (183.6 cfs), $p_2/p_1 = 2.5$ at $t_1 = 25$ C, (4) air cooler, (5) throttle valve, (6) throttle valve during blower tests, (7) by-pass valve, (8) test chamber, (9) nozzle for volumetric measurements, (10) two-stage rotary compressor 37 cu m per hr (1306.5 cfhr), $p_2/p_1 = 6$, (11) safety valve, (12) valves for change-over to rotary compressor, (13) constant-pressure valve, (14) main oil tank, (15) intermediate oil tank, (16) measuring oil tank, (17) change-over valve for oil measurement, (18) main oil pump, (19) high-pressure oil pump for self-aligning bearing, (20) auxiliary oil pump for measurements, (21) balance to measure moment, (22) balance to measure oil.]

aerodynamic research equipment by the addition of a supersonic wind tunnel, Fig. 5, which corresponds approximately in design to that at the Swiss Federal Institute of Technology, Zurich, Switzerland. The axial blower has, however, only a suction volume of up to 6 cu m per sec. (211.9 cfs) with a maximum pressure ratio of 3. The compressed air follows a closed circuit first through a cooler, which serves simultaneously as a stabilizing filter, then into the test chamber, and from there back to the blower which is driven by a 750-kw motor via a Ward-Leonard set. The toothed cradle gearing is new to this plant and enables the driving moment transmitted to the blower to be read off on a balance during operation. It is thus also possible to use the wind tunnel as a blower test chamber.

The closed wind tunnel can be evacuated or charged by a compressor so that the Reynold's number may be changed independent of the Mach number. A striometer is included in the measuring equipment of this plant.

# Wind Power

INVESTIGATIONS directed toward the utilization of wind power on a large scale are to be undertaken by the British Electrical and Allied Industries Research Association and a new Section on Power Generation has been set up, according to *Engineering*, January 30, 1948. Interest in the economic possibilities of such developments has been raised by the successful operation of the 1000-kw plant, situated on the 2000-ft mountain known as Grandpa's Knob, Rutland, Vt., a description of which appeared in the June, 1941, issue of MECHANICAL ENGINEERING, pages 473 and 474. The matter has been followed up in this country by the Federal Power Commission, who have made extensive studies and prepared detail designs for 7500-kw and 6500-kw wind-power electric-generating plants.

The terms of reference of the new Section of the British Electrical Research Association are "to study the technical and economic problem of large-scale aerodynamic generation in Great Britain; including the collection of all available information and evidence, the principles of the selection of sites and the wind energy derivable therefrom, the co-ordination of wind-driven generators with supply systems, the essential design features of wind-driven generators, and the design problems which remain to be solved." Some work on small-scale wind-power generation has been done by the Section on Rural Electrification, from the point of view of electricity supply to small isolated communities in remote districts. The shortages of fuel and power in the past, however, roused interest in the possibilities of wind-power generation on a substantial scale and, in December, 1947, the Electrical Research Association convened a conference of Ministries and other bodies likely to be interested in the matter. The members of the conference were unanimously in favor of researches being undertaken and, as a result, the new Section has been set up.

# Linear Accelerator

AN announcement from Yale University reveals that Yale physicists have already attained energies of one million volts in a new, atom-smashing, linear accelerator which is expected to unlock new secrets of the atom.

Instead of using heavy particles of matter to smash the atom at extremely high speeds, the linear accelerator works on the principle of using the electron—the light, negatively charged particle of the atom—to smash the nucleus. It builds up to the speed of light—186,000 mps—and is powered by high-frequency amplifiers operating on the same principle as the amplifiers which control high-powered radar transmitters.

The method of operation of the linear accelerator is the firing of electron particles in a straight line through a series of round, hollow pillboxes made of steel and lined with copper to provide maximum conductivity. These pillboxes are connected by small holes and are from 3 to 7 in. long. Each one weighs approximately 75 lb.

The system is powered by coupling these pillboxes, termed "cavity resonators," to high-powered amplifiers and synchronizing the flow of electron particles from a single external source by means of a master amplifier. Other linear accelerators now in existence have to depend on individual self-excited oscillators and require high machining tolerances so that the pillboxes fit together exactly.

The heart of the system, the pillbox, is relatively inexpensive. When a group of them is strung together in a series and synchronized, the average pillbox will generate an electric voltage equal to approximately 2 million volts each.

A pilot model is now being built at the Yale Sloane Physics Laboratory which is expected to produce energies of from 15 million to 20 million volts by June of this year. The series of pillboxes will measure from 5 to 6 ft in length.

A linear accelerator producing one billion volts—the highest energy ever attained by man—would extend for a length of approximately 400 to 500 ft and would cost from $2 million to $5 million.

The pillboxes are evacuated of air and this vacuum is maintained during all experiments. An "electron gun," in the form of a high-voltage vacuum tube, emits streams of electron particles into the pillboxes which start at relatively low speeds

FIG. 6 ATOM-SMASHING LINEAR ACCELERATOR WITH ITS DESIGNER, HOWARD L. SCHULTZ

(In foreground is a high-powered amplifier which helps propel electrons along at speeds of 186,000 mps through steel and copper pillboxes shown in background.)

of 5000 volts and then build up to multimillion voltages depending on the number of pillboxes which are used.

The electrons are "kicked" along from pillbox to pillbox by tremendous frequency pulsations of one million watts from each high-frequency amplifier which operates at 600 million cps. The amplifiers create pulsations lasting only 0.00001 sec and there are about 100 such pulsations each second. Each of the pillboxes has its own amplifier and all of the amplifiers are hooked up to a master source which controls the entire movement of the electron from its source to a target.

The linear accelerator is said to have an advantage over the conventional atom smashers, in addition to being lighter in weight, in that the electron beam which is shot through will pierce a foil at the end of the vacuum and bombard any target which is there without loss of energy. It will not produce radioactivity to as great an extent as that found in the heavier elements which are employed in more conventional atom smashers.

Four major problems in fundamental nuclear physics will be explored at Yale, using the linear accelerator as a tool. They include the following:

1 The electrons accelerated by the atom smasher will be used to produce nuclear transmutations—the complete conversion of one element into another—and the new products will be studied.

2 The entire problem of just how a fast electron behaves when it is passing near the nucleus of an atom is an unknown factor. The forces which emerge from this reaction are neither electrical nor gravitational in character but have energies many million times such forces. How does the electron get out of the nucleus is one of the problems to be studied. Also, what are the peculiar fields of force?

3 When a fast electron is stopped suddenly, x rays or gamma rays are produced. Theoretically, billion-volt x rays can be produced by the linear accelerator which will be extremely useful in nuclear studies.

4 The atom-smasher may answer an important question of science: How are fast electrons absorbed in matter?

# Air Heat Pump

IN 1946, Drayer-Hanson, Inc., Los Angeles, Calif., manufactured and installed approximately 150 self-contained package-unit heat pumps which use the atmosphere as the heat source. This heat-pump system, known as "Airtopia," is said to give complete comfort regardless of seasonal or diurnal variations of heat or cold, dryness or humidity, without personal attention or adjustment. The installations vary in size from domestic to semicommercial (3, 5, 7½, and 10 hp) and are now operating in the states of California, Texas, Arizona, Nevada, Louisiana, Alabama, Georgia, Florida, and Oklahoma.

A heat-pump system (commercial or domestic) which uses the atmosphere as the heat source is shown in Figs. 7 and 8. During the heating cycle an electric motor drives a refrigeration compressor which forces Freon-12, or any other suitable refrigerant, through the condenser and expansion valve into the evaporator. The low-pressure, low-temperature liquid refrigerant absorbs heat from the outdoor air as it flows past the evaporator coils and is changed into a low-pressure, low-temperature vapor. The vapor is then drawn into the compressor where its pressure is increased. In making this cycle the refrigerant absorbs heat while passing through both the evaporator coils and the compressor; the heat absorbed in the evaporator is called heat of evaporation and that absorbed in the compressor is referred to as the heat equivalent of the work of compression. The heat thus absorbed by the refrigerant is picked up by the air which passes over the condenser and is thereby transferred to the space to be heated. Two motor-driven fans are used; one is used to force the outdoor air past the evaporator coils and the other to draw the return air and some fresh outdoor air through the condenser. The air used as the heat source gives up heat in passing over the evaporating coils. In giving up heat to the evaporator the temperature of the outdoor air is lowered; this air is then discarded to the outside from whence it was taken.

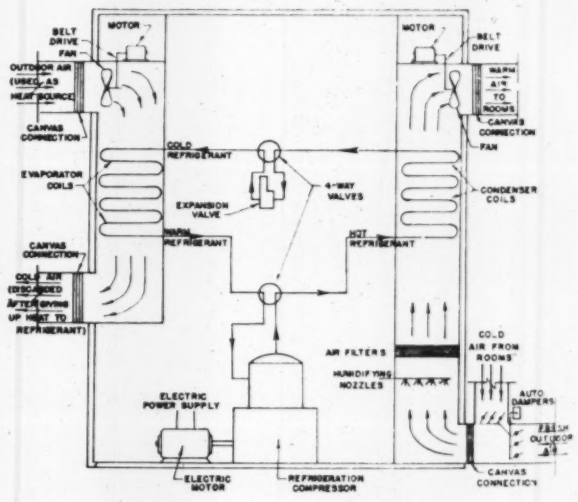



FIG. 7 SCHEMATIC DIAGRAM OF A HEAT PUMP USED TO HEAT A HOUSE

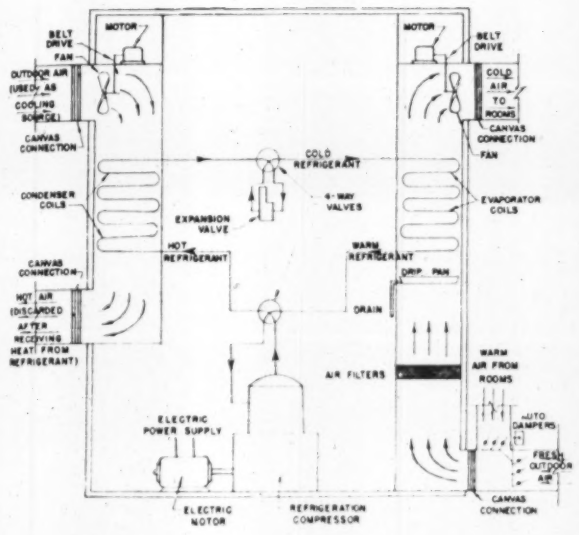



FIG. 8 SCHEMATIC DIAGRAM OF A HEAT PUMP USED TO COOL A HOUSE

This heat pump may be used to cool the house during summer by interchanging the functions of the condenser and the evaporator. This is done automatically by means of the two four-way solenoidal valves. (If the change-over from heating to cooling is done manually, the two four-way solenoidal valves may be replaced by eight ordinary valves; and the change-over is made merely by closing four valves and opening the other four valves.) Fig. 8 is a schematic diagram of the air heat-pump system used for cooling. Here outdoor air is brought in to absorb heat from the condenser and is then discarded as shown. At the same time, fresh air and return air are forced past the evaporator where the air mixture is cooled and then discharged to the space to be air conditioned.

The foregoing material is abstracted from Engineering Experiment Station Bulletin, vol. 1, no. 4, published by the University of Kentucky, entitled, "Development of the Heat Pump," by E. B. Penrod, head of the department of mechanical engineering. Mr. Penrod's paper, "A Review of Some Heat-Pump Installations," appears in the August, 1947, issue of MECHANICAL ENGINEERING, pages 639 to 647.

# Descaling Plant

INSTALLATION of what is believed to be the largest, most modern, and most complete sodium-hydride descaling plant in the world, has been announced by Lukens Steel Company, Coatesville, Pa. It is claimed that the equipment, installed at a cost of approximately $750,000, can be used on all Lukens Clad steels, including Nickel-Clad, Stainless-Clad, Inconel-Clad, and Monel-Clad, on alloy steels and on all metals which are not affected by molten caustic or by heating at 700 F, for the removal of metallic-oxide scale, and to impart an attractive pearly-gray matte finish to plate surfaces.

Appreciable savings in metal, more uniformly descaled surfaces, and shorter descaling time are the principal advantages reported to be offered by the sodium-hydride process over blast cleaning. Metallic-oxide scale is removed by first immersing the work in the sodium-hydride bath and then immersing it, while hot, in a water-quench tank. The scale, loosened by the sodium-hydride bath, is carried off the work by steam which is created when the heated work is immersed in the water quench. The reaction stops when the reducing action on the scale is finished; overtreatment is said to have no effect on the underlying metal.

The sodium-hydride bath may be likened to an alkaline pickling bath which requires no electric current. In the course of removing scale, which is accomplished without contaminating the bath, caustic soda results from the reaction of sodium hydride and metallic oxide.

The new facilities for sodium-hydride descaling include a large preheating furnace where the work is brought to a temperature of 700 F. This preheating is necessary to prevent cold work from lowering the temperature of the sodium-hydride bath to less than its constantly maintained 700 F.

From the furnace, the work is lowered into the sodium-hydride bath which is produced by the reaction of sodium and hydrogen. Theoretically, each pound of sodium requires 7.8 cu ft of hydrogen which is obtained from ammonia gas in a dissociator from which nitrogen passes off as an inert gas. As the hydrogen feeds into mixing boxes in the sodium-hydride tank, excess hydrogen is burned off continuously to show that it is being fed properly to maintain the correct solution in the tank.

The work remains in the sodium-hydride solution from 8 to 20 min. Then it is quenched in the adjacent water tank, where the steam which is generated helps remove the loosened scale from the surface.

As a preliminary to pickling, the work is immersed in a sulphuric-acid bath to neutralize any remaining caustic and is then brightened by dipping in a nitric-hydrofluoric-acid bath. Following these pickling operations, the work is subjected to a holding bath in water, then to a high-pressure spray to remove all acid. The final bath is a hot-water rinse, resulting in a clean, bright surface.

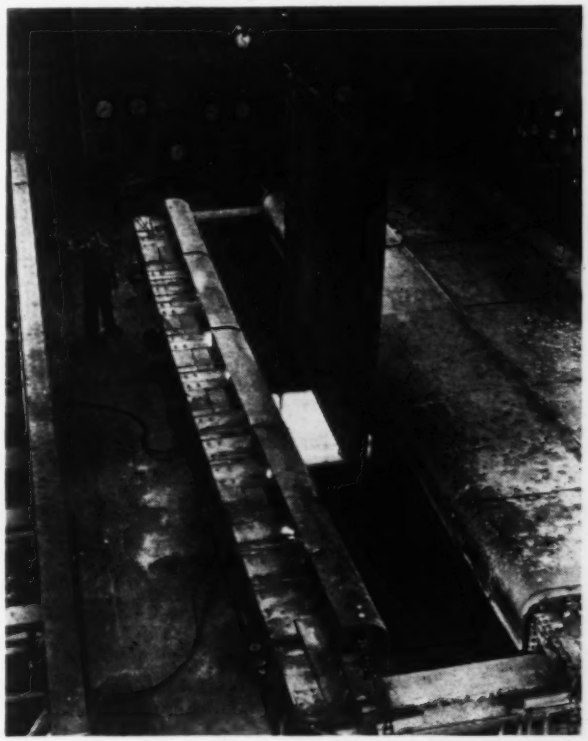


FIG. 9 CLAD-STEEL PLATE BEING LOWERED INTO SODIUM-HYDRIDE BATH

# Subminiature Motors

A MINIATURE electric motor, said to be the smallest in the world, has been demonstrated in the United States for the first time early this year. The motor has been made possible by a new type of armature known as the "gap-ring armature."

It is the smallest of a series of subminiature direct-current electric motors invented by J. V. and J. E. G. Eurich, of Lancashire, England. The motors, known as "Electrotor," will be manufactured and sold in this country by the Electrotor Division of United States Instrument Corporation, Summit, N. J.

The Type 001 weighs less than a gram, measures only $^3/_{16}$ in. in length and diameter, requires $1^1/_2$ volts, and runs with high efficiency at a speed of 7000 rpm. This particular size has not been engineered as a practical unit, but rather to demonstrate size possibilities.

The smallest unit engineered for volume production is the Type 240, a motor that measures only $^9/_{16}$ in. in width and $^7/_8$ in. in diameter, and weighs $^3/_4$ oz. It requires 3 to $4^1/_2$ volts, consumes less power than a flashlight bulb, and has a speed of 5000 rpm free running.

The motor dispenses entirely with the separate commutator and the complicated segmentary winding. Its motive power is derived from a permanent magnet and from an electromagnet operated by a dry-cell battery of the type obtainable at any electrical-appliance shop. It is claimed to be equal to or superior in efficiency to comparable electric motors.

The Electrotor has no soldered parts whatever, and commutation is affected by direct contact with the armature. It is reported to be self-starting, instantly reversible, and operates with equal efficiency in both directions.

The miniature motor, see Fig. 10, consists of the gap-ring armature winding, mounted on a bobbin and spindle that revolves freely within a permanent ring magnet. The armature can be considered a horseshoe electromagnet in which broken iron rings form the core, and the outer winding the magnetic coil.

The contact points on the armature, whose position relative to the armature gap in the core plainly determines the flux distribution in these broken iron ring cores, are, in effect, the brushes.

According to the *Journal of Scientific Instruments*, vol. 24, no. 6 (Great Britain), the smallest motor ($^3/_{16} \times {}^3/_{16}$ in.) can be used for special highly sensitive instruments. The three other types, $^7/_8$ in. diam $\times$ $^9/_{16}$ in. wide (consuming less than a flash-lamp bulb), $1^1/_2 \times {}^3/_4$ in. (taking $4^1/_2$ to 6 volts) and $1^1/_2 \times 1^1/_2$ in. (taking from 6 to 24 volts) have many uses, such as for air conditioning in trains and motor cars, for windscreen wipers, motion-picture cameras, projectors, models, model aircraft, automatic razors, hair clippers, movements in machines, radio control of various kinds, time fuses in projectiles, stroboscopes, scientific instruments, and domestic labor-saving devices.

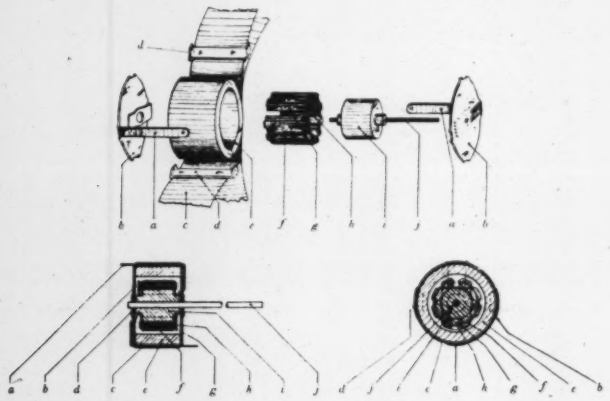


FIG. 10 MINIATURE ELECTRIC MOTOR

[(*a*) Contact, (*b*) end plate, (*c*) cover tape, (*d*) securing clip, (*e*) permanent ring magnet, (*f*) gap-ring armature winding, (*g*) core of iron wires, (*h*) nylon-covered copper wire, (*i*) bobbin, (*j*) spindle.]

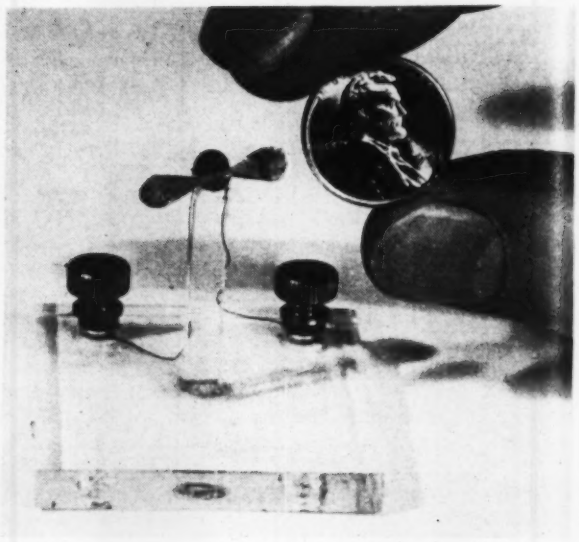


FIG. 11 MINIATURE ELECTRIC MOTOR COMPARED WITH A PENNY

# Astro-Window

A NEW astro-window through which navigators aboard long-range stratosphere airliners will "shoot" the stars, even in daytime, has been developed by Bausch & Lomb Optical Company, Rochester, N. Y.

Designed for Air Force and commercial ships, the streamlined window consists of two plates and is said to be capable of withstanding a total force of $3^1/_2$ tons. Its surface projects only $2^1/_2$ in. above the ship's skin as compared to 6 in. in the old-type speed-retarding astro-domes.

The astro-window's outer plate is a large optical lens that has been ground and polished to reduce refraction errors regardless of the angle of the sighting instrument. The inner plate is plastic and houses a defrosting system that should prove invaluable to celestial navigators.

It is reported that on stratosphere flights, the astro-window eliminates much of the difficulty encountered by navigators in shooting the stars, even the dimmer ones, regardless of the weather or the hour of day or night.

The higher man flies, it is said, the plainer the stars become, allowing for continuous and accurate aircraft fixes anywhere over the earth. Contrary to popular notion, the higher you go, the simpler sextant observations become. In the stratosphere the sky tends to become darker and stars are readily seen in the daytime.

On overseas hops, fixes are taken about every half-hour with modern bubble sextants, two of which are standard equipment on long-range aircraft.

# Liquid Nitrogen

HIGH-PURITY liquid nitrogen, which can reduce the temperature of a piece of metal to —320 F in a few minutes, is now being used for expansion-fitting. The Linde Air Products Company reveals that it has made liquid nitrogen available in large volumes and has developed various machines and equipment for using it.

Though it is generally easier to expand the outside member of an assembly than to shrink the inside part, the size or hardness, or the possibility of distortion may make shrinking advisable. Fits such as valve-seat inserts, cylinder liners, and bushings are almost impossible to make by expanding the outer member because these are usually too large or complex, have finished external surfaces, or have been heat-treated.

Liquid nitrogen, being inert, is recommended for this work by the company. Liquid oxygen has been used for shrinking, especially during the war, but the properties of the oxygen-rich atmosphere create a potential hazard. Liquid air has also been used, but is not recommended since the nitrogen boils off first, leaving liquid oxygen.

Expansion-fitting is said to be easy with liquid nitrogen. For small-lot operations, a stainless steel bucket containing a well-insulated internal receptacle, such as the one shown in Fig. 12, is satisfactory. The liquid nitrogen is placed in the inner container. The wooden cover is vented to avoid pressure build-up in the vessel. Tongs or a perforated ladle are used to dip small parts directly into the liquid.

For mass-production work, a machine such as the one shown in Fig. 13 has been developed. In this machine the parts come into direct contact with the liquid nitrogen. Parts are fed automatically or manually into the top of the machine, and ejected after cooling as needed. As in nearly all such machines, the cold nitrogen vapor is used to precool the part. In some machines only the vapor is used, the parts passing counter to the flow of vapor.

To supply the demands of large users, the company furnishes liquid nitrogen in 100-gal mobile-transfer tanks. These units are provided with heat-exchanger coils enabling sufficient head pressure to be built for forcing the liquid nitrogen into the cold-treatment machine. For small users liquid nitrogen can be obtained in 5-, 15-, 50-, or 100-liter insulated containers.

FIG. 12 SIMPLE DEVICE FOR USING LIQUID NITROGEN

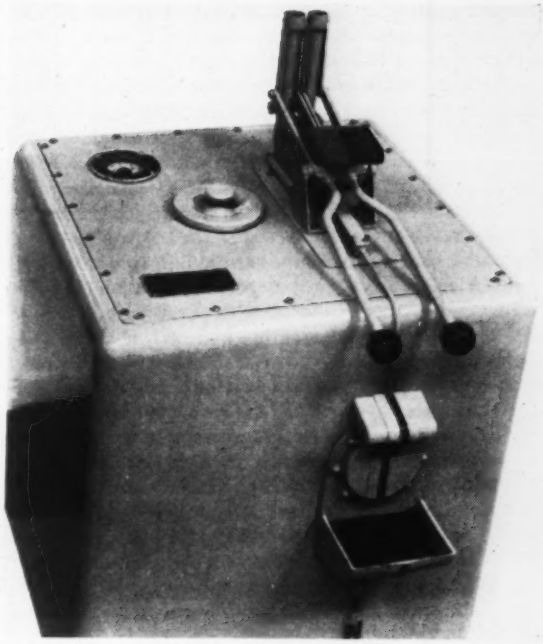


FIG. 13 DIRECT-IMMERSION-TYPE LIQUID-NITROGEN COLD-TREATMENT MACHINE

Precautions necessary with this process are as follows: Care must be taken to assemble the parts quickly into final position. Parts warm up quite rapidly. Unless placed properly in position quickly the insert may be warmed sufficiently to bind.

Good ventilation should be provided. Goggles are desirable and the operator should wear gloves for handling the cold parts. If liquid nitrogen is spilled on the hands it causes effects similar to a burn, therefore it must be handled with care.

# Ceramic-Coated Steel

EARLY in the war when the shortage of nickel and chromium appeared imminent, the National Bureau of Standards undertook an extensive research program involving the possible replacement of nickel-chromium alloys by ceramic-coated steel in a number of high-temperature applications. As a result of this research, a new type of ceramic coating for high-temperature protection of mild steels was developed and used by the Army and Navy on certain aircraft and vehicle exhaust systems subject to severe service conditions. As these coatings have been shown by laboratory and service tests to be superior to conventional enamels for high-temperature service, they have many important peacetime applications.

The new NBS coatings embody several outstanding features including high resistance to chipping under repeated severe thermal shock, protection of the metal against oxidation during prolonged exposure in air at temperatures up to about 1250 F, freedom from the cracking and blistering produced in conventional porcelain enamels under comparable conditions of high temperatures and severe thermal gradients, and a mat surface that does not show highlights and therefore decreases the visibility.

The coatings first used during the war in the effort to meet the existing need were of the type which had previously been used

on a limited number of automobile exhaust manifolds. These were actually porcelain enamels, and while giving valuable protection, did not fully meet the requirements of high-temperature service. However, there are now a number of industrial enamelers who have had experience in regular commercial applications of the new type of ceramic coatings developed by the Bureau to meet the desired requirements. In NBS tests, specimens so coated have withstood 10 quenches with cold water from 1200 F, the resulting permanent distortion of the metal causing no noticeable effect upon the coating.

The ceramic coatings developed at the Bureau were originally designed for the protection of a specific type of metal against corrosion under specialized service conditions. However, up to that point, only a beginning had been made in a whole new field of development. Now a number of universities and research organizations are conducting projects on ceramic coatings, sponsored by the U. S. Air Forces and the Department of the Navy. The more recent projects have been directed toward ever-increasing temperatures of service, the coatings being applied in many cases to high-temperature alloys. This is also the case in the project on high-temperature coatings sponsored for several years at the National Bureau of Standards by the National Advisory Committee for Aeronautics. Turbine blades, combustion chambers, and essential parts of temperature- and pressure-measuring devices are representative of the articles for which coatings are being sought that will protect the alloys against corrosion in operation.

Temperatures at which protection is being sought are limited only by the melting or softening points of the metals or alloys being coated. In some cases it is thought that if sufficient insulation can be provided by the coating, the coated metal may even be operated at gas temperatures substantially exceeding the maximum temperature at which the metal itself will retain sufficient strength.

There are two fundamentally different types of service in which high-temperature ceramic coatings are applicable. One of these is long-time service (hundreds or even thousands of hours) within a temperature range that may be arbitrarily stated as 1200 to 2000 F. The other is service for periods of a few seconds up to perhaps five or ten minutes, where the gas temperatures may be on the order of 3500 F and above. Within limits, and subject to further improvement, either of these conditions can be met at the present time. But the combination of the two—longer time and high-temperature range—is a goal for future achievement.

## New-Type Ships

INFORMATION concerning Nary Department plans for the building of new-type ships and the conversion of others for different uses is revealed in an article in the February, 1948, issue of the *Report*, published by the Naval Ordnance Laboratory. One announcement noted new classifications for four fleet submarines and four Gearing Class destroyers. A later announcement stated still another group of submarines was being streamlined to increase their submerged speed. These submarines will be equipped with the latest American devices and many developed by the Germans during World War II. The alteration work, which, according to the Navy, is being done while the vessels are undergoing normal overhaul in Naval shipyards, involves streamlining the hulls by reducing the size of their superstructure and by removing deck guns and other topside appurtenances in order to cut down underwater resistance. The "schnorkel," a breathing-tube apparatus developed by the Germans, is being installed on the undersea craft under the program.

Known as the "Guppy" program, the alteration plan is the first of a series of basic steps in the Navy's long-range effort to design and construct the true submarine. "Operation of the altered submarines," the Navy said, "will provide information useful in perfecting plans for the two new submarines recently authorized by Congress and will aid the training of Navy antisubmarine forces against high-speed submerged undersea fighters." The new submarines referred to are the Tang and the Trigger, which when first announced, were said to have been designed to be the world's fastest. (See MECHANICAL ENGINEERING, November, 1947, pages 927 and 928.)

The earlier announcement, which stated the reclassification of the eight Navy vessels, noted that two of the submarines have been assigned as radar picket vessels. Another submarine will be used as a transport submarine; while the fourth will be known as a guided-missile submarine. Two of the 2400-ton destroyers mentioned were designated as destroyer escorts. The other two destroyers have been classified as hunter-killer ships and will be primarily assigned to antisubmarine hunter-killer duties.

The Navy's plans for postponing work on the two guided-missile ships, Kentucky and Hawaii, were also revealed and Congress will be asked to transfer the funds now earmarked for those ships to build six other warships of more immediate use to the Navy. One of the ships, it was said, will include a new-type aircraft carrier which will be capable of handling the larger and heavier planes which are now under development. All this is part of the Navy's general preparedness plan.

## Electric Radiant Heating

A NEW electric radiant-heating panel which generates heat in the ceiling has been developed by the U. S. Rubber Company, Passaic, N. J. The panels, called Uskon, are heated by a conductive rubber-resistance element. Rubber is normally an excellent insulator against electricity. In Uskon, however, scientists reverse the chemical nature of the rubber to make it conduct electric current.

A company spokesman said the mounting cost and scarcity of oil, gas, and coal will stimulate interest in electric heating. He claimed that the new system is the "most practical, efficient, and esthetic" ever developed. It can be used wherever electricity is plentiful. Present estimates by U. S. Rubber engineers indicate that it can be operated as economically as other heating systems in well-insulated houses where electricity can be obtained for $1\frac{1}{2}$ cents per kwhr or less. To illustrate the economics of this type of heating the engineers selected a typical house, consisting of a large living room, kitchen, two bedrooms, and hall, and estimated the cost of heating for a year in twelve different cities. The house contains 8000 cu ft of space and it is well insulated to reduce heat loss to a minimum. The estimates are based on minimum power rates reported for the twelve cities. They do not take into consideration any special rates for heating that may be granted in various localities. They allow for continuous and uniform operation 24 hr per day at 68 F and do not make provision for savings that may be realized by operation of the system at lower temperatures in some parts of the house. The chief determining factors in the study are the power rate and climate. The estimates for a full year of operation are as follows:

Pittsburgh, $190.00; Buffalo, $247.50; New York, $252.00; Jacksonville, $39.30; Atlanta, $66.93; Memphis, $47.00; Denver, $291.60; Seattle, $220; San Francisco, $43.00; Bangor, $170.20; San Diego, $61.00; Chicago, $310.00.

The standard size of the heating panels is 4 × 4 ft. Other sizes are made to order when needed. The panels are about 1/4 in. thick, resembling standard interior building boards. They may be nailed to the joists in the ceiling or may be installed over an existing ceiling. There are no wires in the heated area of the panel. Wires bring current to the edge of the conductive rubber. The heating element is sandwiched between several layers of phenolic insulation and the laminated construction is made rigid by a backing of 3/16-in. asbestos board. Aluminum foil on the upper side serves as a reflector to prevent heat from going through the roof.

The panels operate on 220 volts. They are made in two standard wattage densities, 17 watts per sq ft and 22 watts per sq ft. The 17-watt panels are used in rooms with normal heating requirements. The 22-watt panels are used in bathrooms, over large window areas, and in rooms with abnormally high heat losses. The panels usually cover about 70 per cent of the ceiling. To provide the optimum results they are arranged in a peripheral pattern, with a nonheating section in the center of the room which is filled in with standard building board. The peripheral pattern produces a slight air circulation which prevents "stuffiness" and disperses tobacco smoke and kitchen odors.

The temperature in each room is individually controlled by thermostat. The surface temperature of the ceiling averages about 100 F. This affords a flexible system in which certain rooms may be reduced in temperature while others remain at a higher level.

The panels may be finished with paint, paper, plaster, or fabric. Radiators, pipes, and other obstruction which interfere with room decoration are eliminated. There is no smoke, odor, or soot. Coal bins, fuel tanks, and furnaces are also eliminated. No chimney is required although one may be added for decoration.

The ceiling heats up to maximum temperature in about 15 minutes. Room space is comfortable at 68 F because the radiant heat "shines" directly on occupants, eliminating the necessity of warming the air.

The original cost is said to compare favorably with other systems.

## Panama-Canal Conversion

EXCAVATION required for conversion of the lock-and-dam Panama Canal to the sea-level route recently recommended to Congress as a defense against atom-bomb attack would involve removal of enough material to bury a 20-foot highway around the world under nearly three feet of dry earth, with enough mud left over to fill 80 structures the size of the Empire State building, tallest in the world.

Total excavation in the project, which would be the largest single construction undertaking in history, would be 1,070,000,000 cu yd, 750,000,000 cu yd to be excavated in the dry, and 320,000,000 cu yd of wet material to be dredged, the American Society of Civil Engineers was told at its 95th annual meeting in the Hotel Commodore, New York, N. Y.

Theme of the meeting was a symposium on the Panama Canal and the recent proposal to Congress by Governor J. C. Mehaffey of the Canal Zone that a 10-year project, estimated to cost $2,483,000,000, be initiated to replace the present lock-and-dam canal with a sea-level waterway which the engineers making the study say will be virtually indestructible, even by atomic bombing.

Four engineers of the Panama Canal Special Engineering Division, L. T. Crook, F. L. Dye, J. J. Rose, and W. B. Watson, detailed the various construction methods studied and gave cost estimates covering the method selected for the proposed conversion.

The fact that the conversion in a single stage by deep-dredging is preferable to stage-dredging because it would be cheaper, requiring shorter construction period, and interfere less with canal traffic, was stressed.

Large shovels or draglines of 25-cu yd capacity would be used. These are so large a good-sized truck could be driven into the shovels.

Wet excavation would be performed by conventional dredges supplemented by special hydraulic and bucket-ladder dredges capable of dredging to a depth of 145 ft below water surface, deeper than any ever known to have been operated.

The single-stage conversion would save five years of the construction period over stage-dredging methods studied.

Material removed in both the wet and dry excavating operations would be loaded directly into dump scows for disposal in Gatun Lake, and some of the material would be utilized in flood-control construction necessitated by the conversion.

Net savings of the deep-dredging plan over stage-dredging is estimated at $130,000,000.

Personnel required would be reduced by 9000 workers through use of the prescribed methods, with resultant savings reflected in the lower cost of housing, utilities, services, and mobilization.

Man-hours required in the 10-year project would total 307,910 beginning with 7460 the first year, accelerating to 41,330 and 41,360 the next two years, and diminishing slightly in the subsequent years.

About two thirds of the required man power would be unskilled and largely indigenous to the Caribbean area. Contracts with skilled and technical personnel, to be obtained from the United States, would include payment of transportation from the place of recruitment and return, and transportation of government workers' families and household furnishings would be provided,

Cement, steel, and lumber would be obtained from the United States.

## 200-Inch Telescope

WHAT do astronomers expect of the 200-in. telescope atop Palomar Mountain?

William T. Skilling, in an article in the January, 1948, issue of *Sky and Telescope*, answers this question with firsthand authoritative information. He writes that those who will use it do not anticipate sudden and startling discoveries overnight that will be headline news in the morning paper. Research work nowadays bears fruit slowly.

To arrive at some idea of the expected performance of the new telescope it has been customary to compare it with others, especially with the 100-in. telescope at the Mount Wilson Observatory, which is the one nearest it in size. The Palomar mirror being twice the diameter of the 100-in. reflector, has four times as much surface, hence four times as much light-gathering power, which will be its chief asset.

It is natural at first thought to suppose that with four times the light-collecting power, the telescope should penetrate space to four times the distance reached by the 100-in. All that is expected, however, is twice the distance. For doubling the distance of a star makes it only one fourth as bright, thus requiring a telescope to gather four times as much light to make the star as bright as at the shorter distance. Since volume, however, depends on the cube of the distance, the twofold range of the telescope will bring into view a volume of eight times as much space.

It is estimated that the 100-in. telescope photographs extragalactic nebulae (galaxies) that are 500 million light-years away. The 200-in. mirror should double this distance, showing nebulae that are one billion light-years from us.

Similarly, when the giant telescope is used in the study of dwarf stars near us in our own galaxy, the number of such stars observed will be about eight times as great as the comparative few that can be studied satisfactorily with the 100-in. telescope. Also, those stars of this interesting class that are near enough to have been studied already can be much more satisfactorily examined with the larger instrument.

Those who will use the new telescope do not expect much from the increased resolving power, that is, from its ability to produce smaller images that can be better separated by magnification, which would enable better study of close star images and fine details on the surface of a planet or in a nebula. For the size of the tremor image due to the unsteadiness of the air may usually be larger than the diffraction pattern of the image.

Microscopists have avoided large diffraction disks, and thereby have been able to run up useful magnifying power and ability to resolve images, first by using the shorter-wave ultraviolet light. This increased magnifying power is possible from about 1000 diameters to 2000. Then, with the electron microscope, they have been able to increase to more than 50,000 the magnification of their well-resolved images so as to see organisms not visible with light. But they do not have several hundred miles of atmosphere to contend with, as astronomers have.

Nevertheless, one of the accomplishments hoped for from the Palomar telescope will be an occasional instantaneous photograph of Mars. The light of Mars is strong, but it is reduced by the necessity of employing a yellow or red filter in order to make use of the wave lengths that can best penetrate its own atmosphere. Thus time exposures have always been necessary and atmospheric tremor smears out such details as the so-called canals, which have been seen visually by many observers.

It is estimated that, with the increased light the large telescope will give, photographs through a yellow filter can be made in $^1/_{60}$ of a sec. By taking many pictures on movie film, it is believed that some of them may happen to be made at the end of a flicker of the image—when it is momentarily at rest as it reverses its direction and that a small percentage of them may show what the eye can see. One such picture might make a photographic finish of the perennial argument as to the reality of the crisscross markings on Mars.

Of perhaps more general interest among astronomers will be the results that are expected of Palomar in carrying farther among the extragalactic nebulae the work that has been done with the 100-in. mirror. It is felt that the great depth of penetration will settle the question as to whether or not the red shift of nebular spectral lines is a true Doppler effect.

Another outstanding advantage of the Palomar telescope's power to collect light will be evident when it is used in spectroscopic work on dim stars. If a star is so faint that its entire light must be focussed at a point to make it visible, it is obviously useless to try to spread this light out into a set of lines that will reveal the nature of the star. With a fourfold accession of light, a fourfold lengthening of the spectra of dwarf stars and of stars dimmed by distance will give the astronomer a double range in which to employ his spectrograph, and therefore eight times as many such stars of which he can get readable spectra.

Already, spectra of extragalactic nebulae have been made out to distances of nearly half of the 500 million light-years to which dimmer ones can be photographed. Such spectrographic study of other galaxies will be extended with the Palomar telescope just as it is to be extended among the stars of our own galaxy.

Astronomers are looking forward to the better spectra that the large telescope will give with high anticipation that they will lead to answers to two fundamental questions: the sort of atomic changes that keep the stars hot, and whether in the process of these changes are built up the atoms of the various elements. The set of atomic changes announced by Bethe and known as the carbon cycle seems to account for the heat of the sun and of stars that are similar to it; and at the same time it accounts for the building up of the helium atom. Some stars, however, would seem to require a different process, and no explanation has come forward to account for all of the elements.

It is hoped that more and better stellar spectra will show whether or not the stars all have the same proportions of the elements. Are white-hot giant stars like red dwarfs chemically, or do the so-called hydrogen stars have a superabundance of hydrogen? With better knowledge of the composition of stars, and conditions in them it will be easier to say what is their source of energy, and whether all atoms are built up from hydrogen, as helium seems to be.

# X-Ray Thickness Gage

IN answer to the thickness-gaging problems in modern high-speed rolling mills, Westinghouse Electric Corporation has developed an x-ray thickness gage said to offer the following advantages: (1) No contact with the material being gaged; (2) ready access to areas never before gaged; and (3) high sensitivity and accuracy.

Present applications to sheet metals indicate that the gage will increase output of prime sheet, solve some operating problems, and eliminate marring of the surface of the materials being gaged. As a quality-control instrument, this equipment is expected to find application in the thickness control of hot metal and glass sheet, aluminum foil, plastics, paper, and other sheet and strip materials.

The actual gage, see Fig. 14, consists of two x-ray sources and one phototube pick-up device. Relative to the two x-ray sources, the pick-up is at the apex of a right angle. Radiation from the lower x-ray source is directed up through the sheet being gaged so that the transmitted rays will strike the pick-up. X ray from the upper source is directed horizontally

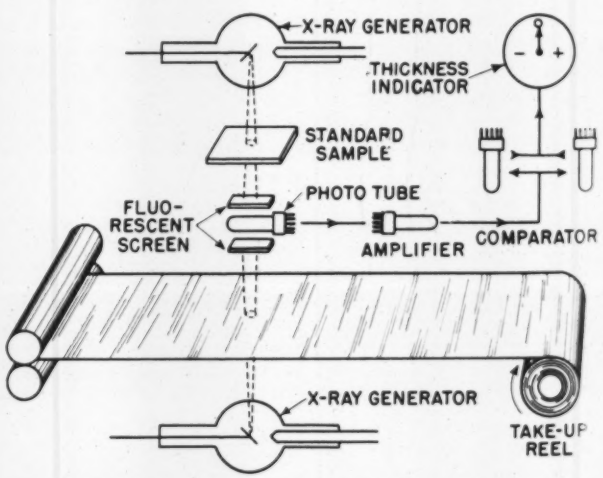



FIG. 14 SKETCH SHOWING ARRANGEMENT OF COMPONENTS OF X-RAY THICKNESS GAGE

through a standard sample of correct thickness; that transmitted strikes the same pick-up. The two x-ray sources emit radiation 180 deg out of phase so that their rays alternate in striking the pick-up. The pick-up compares the intensities of the two x-ray beams after a large part of their radiation has been absorbed in the standard sample or test sheet.

Any disparity in the intensities of x rays from the two sources hitting the pick-up is registered on the indicator instrument. At full deflection of the indicator needle a red light on the instrument goes on and a throwout or other mechanism is actuated through electronic circuits.

Since the sample and test sheet are of the same material and the x radiation from two sources is maintained at constant intensity, the transmitted radiation depends only on the thickness of the material being gaged.

Positive and negative readings showing the thickness differential above or below the standard sample are shown on an instrument within view of the operator. The gage automatically rejects off-gage material in flying shear applications or controls the screwdowns to maintain uniform thickness in material coming from a cold mill.

One model now installed on a tinplate line is designed for thickness of sheet from 0.005 to 0.050 in., but the basic equipment is the same for other applications. The indicator needle on the gage instrument will react to a variation of 0.0001 in. in a 0.1-in-thick sheet.

It is unaffected by fluttering of the sheet, surface coatings such as lacquer, or by atmospheres heavy with palm oil, steam, and water. Normally mounted on a slide so that it can be removed from the pass line, it can also be arranged to rove across the sheet.

## Railroad Motive Power

A DEVELOPMENTAL oil-burning gas turbine intended for possible locomotive application and volume production of 6000-hp Diesel-electric locomotives were features of the Railroad Executive's Conference held in Schenectady, N. Y., March 2 and 3, 1948, under the joint sponsorship of the General Electric Company and the American Locomotive Company.

Charles E. Wilson, member ASME, president of General Electric Company, and Robert B. McColl, member ASME, president of American Locomotive Company, in addresses stressed that the Diesel-electric is today's outstanding locomotive power plant, and that it would continue in that capacity for the foreseeable future. They pointed out that the two companies, which combine their efforts in Diesel-electric design, engineering, and construction, also are pioneering in gas-turbine research and development.

G. W. Wilson, manager, locomotive and car equipment divisions, General Electric Company, told the conference that his company had spent four years of development work on the gas-turbine power plant.

While initial performance of this experimental unit was promising, he said the potentialities of a new prime mover can be truly evaluated only after exhaustive tests in the factory and on the rails, pointing out that it had been operated in factory tests almost continuously since September, 1947.

Nineteen feet long and weighing 19,000 lb, the experimental locomotive gas turbine is designed for 4800 shp at 2700 rpm and 1400 F turbine-inlet temperature. Over-all efficiencies of approximately 17 per cent, which is the design efficiency, have been obtained in test runs. For a full description of the design and construction of the unit, see the article "Design Features of a 4800-Hp Locomotive Gas-Turbine Power Plant" by Alan Howard, member ASME, which is published on pages 301 to 306 of this issue.

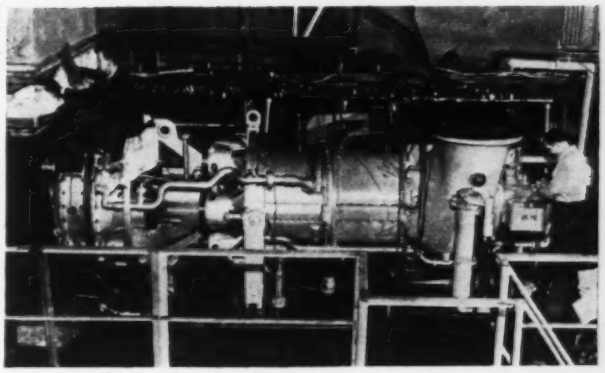


FIG. 15 4800-HP OIL-BURNING LOCOMOTIVE GAS TURBINE ON TEST STAND

After inspecting the gas turbine in the morning, the guests toured the American Locomotive Company plant, where $20 million has been invested since the war to build new Diesel-electric locomotives. At the Alco plant they witnessed the volume production of a new line of Diesel-electric locomotives for freight, passenger, and road-switcher service.

The American Locomotive Company has built more than 75,000 locomotives since its inception, Mr. McColl said. In 1924 Alco and General Electric united their facilities to build the first commercially successful Diesel-electric locomotive in the United States, the locomotive still seeing daily service, he stated. "It was the start of a joint production effort which to date has placed thousands of Diesel-electrics on the American railroad, and is currently capturing 40 per cent of the market," Mr. McColl declared.

In 1946 Alco's production was 75 per cent steam locomotives and 25 per cent Diesel-electrics; this has changed to an estimated 92 per cent Diesel-electric production and 8 per cent steam in 1948. Mr. McColl pointed out there are 35,000 steam locomotives on the American railroads today, and that it is estimated they will be replaced by 20,000 Diesel-electrics in the next decade.

## Ultrasonic Paper Drier

PAPER dried by sound is one of the latest achievements to come out of the research laboratories, according to an article in the February, 1948, *Pulp and Paper Bulletin*. The Ultrasonic drier, used for this purpose, is a powerful sound-making machine which can be likened to a super bicycle siren. Experiments are now being conducted in one of the southern paper mills and, if successful, it is expected that the drier will speed up papermaking by at least 20 per cent.

Briefly, the drier works as follows: When the drier is turned on, a rapidly rotating disk forces the air out through holes around its rim and this air is cut by vanes in another, turbine-like stationary disk. The pulses pass through acoustic horns, setting up tremendous sound vibrations which cannot be heard by the human ear. These vibrations are then applied to the paper which is ready to be dried, agitating it, and literally knocking off the water, thus considerably shortening what has always been a long procedure. Other adaptations of the Ultrasonic sound-maker have been used to recover valuable chemical and metal dust in various industries, and are now being installed in the chimneys of a number of paper mills to prevent loss of certain chemicals heretofore dissipated during the papermaking process.

# ASME TECHNICAL DIGEST

*Substance in Brief of Papers Presented at ASME Meetings*

## Steam-Electric Power Station

**The 2000-Psi, 1050 F, and 1000 F Reheat Cycle at the Philip Sporn and Twin Branch Steam-Electric Stations,** by Philip Sporn, Mem. ASME, American Gas and Electric Service Corporation, New York, N. Y. 1947 ASME Annual Meeting paper No. **47—A-87** (mimeographed; to be published in Trans. ASME).

A discussion of the design employing 2000 psi, 1050 F initial temperature with 1000 F reheat at the Philip Sporn Plant, including the location of the plant on the system, features of the site, the heat cycle, turbine, boiler, and plant layout, is given. A net plant heat rate of 9270 Btu per net kwhr output is expected.

### TURBINE FEATURES

The cross-compound turbine is a new combination of high-pressure and low-pressure turbines. The 3600-rpm high-pressure element has a rating of 35,000 kw and a capability of 42,000 kw. Its throttle conditions are 2000 psig, 1050 F. The two emergency stop valves as well as the turbine inner shell will be chrome-nickel-molybdenum columbium stabilized. The turbine outer shell will be made from molybdenum-vanadium.

The 1800-rpm low-pressure element has an intermediate-pressure turbine in tandem with a double-flow low-pressure section. The whole is rated at 95,000 kw with a capability of 108,000 kw, and its generator will be almost identical with those at Glen Lyn No. 5, and Tidd No. 1 and No. 2. The intermediate-pressure section receives steam from the reheater at 375 psig, 1000 F, and exhausts at about 8 psia to the double-flow low-pressure section. Its high-temperature parts will be made from molybdenum-vanadium.

Among the features said to improve the reliability and safety of these turbines are the following: Protection against sudden temperature changes by an initial pressure regulator; protection against excessive starting speeds by a two-speed, motor-operated, synchronizing device on the main operating governor; automatic steam-seal regulator and unloading valve; and automatic low-vacuum trip.

### BOILER

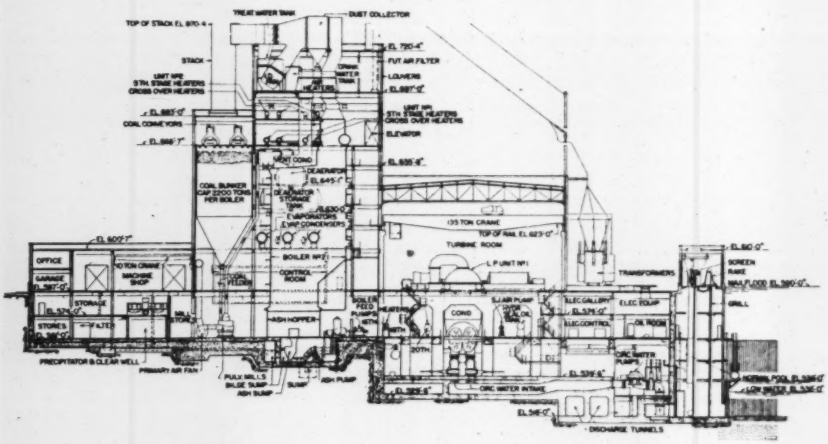
The total heat input of 1,300,000,000 Btu per hr to produce 150,000 kw gross generation makes the boiler one of the largest, if not the largest from the standpoint of net input, that has been projected anywhere. It is designed for maximum continuous steam output of 935,000 lb per hr at 2035 psig, 1050 F at the superheater outlet. A temperature of 1060 F will be maintained between 850,000 to 925,000 lb per hr by an attemperator between the primary and secondary portions of the superheater.

After passing through the high-pressure turbine, the steam will be exhausted at around 400 psi, and some 850,000 lb per hr will be returned at 650 F to the reheater where it will be raised to 1000 F. This temperature will be maintained at 1000 F between flows of 750,000 and 850,000 lb per hr by an attemperator just before the inlet header to the reheater.

Flue gases discharged from the Ljungstrom air heaters go into the stack at about 235 F. The 15-in-long cold-end layer of the air heater will be made of Corten steel, which, together with recovery of air heated by boiler-room radiation losses, will resist corrosion caused by the low flue-gas temperature.

Five coal pulverizers will be furnished for each boiler. There will be ten burners per boiler of the multiple intertube type. These fire vertically downward into the completely water-cooled tangent-tube furnace.

An outstanding feature will be the attempt to run without induced-draft fans. To do this the entire casing will be made tight for a furnace pressure of 15 in. of water. However, induced-draft fans will be installed in case this forward step in the art of coal burning is not successful.



GENERAL CROSS SECTION OF PHILIP SPORN PLANT

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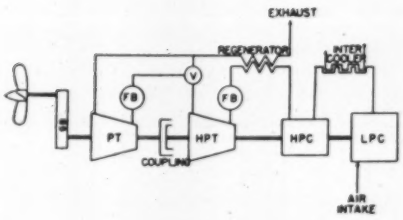
# Gas-Turbine Power

**Discussion of Transmission Systems for Marine Propulsion Gas-Turbine Power Plants,** by W. E. Hammond, U. S. Maritime Commission, Washington, D. C. 1947 ASME Annual Meeting paper No. 47—A-69 (mimeographed).

This paper discusses the various transmission systems available today to determine which might offer the most attractive prospects in connecting the gas turbine to the marine propeller for merchant vessels. It is not intended that a solution be established for every gas-turbine power-plant application but rather that a general solution be sought which has the widest application. It is recognized that certain special applications will involve special circumstances, thus establishing a new evaluation problem. It is believed that these cases can be handled only on an individual basis.

According to the paper, the following points are some of the requirements that a marine transmission system should possess. (1) It must be capable of reducing the revolutions from those required by the prime mover to those required by the propeller; (2) it must be reliable and simple in operation within the capabilities of the crews that are available; (3) the transmission losses should be a minimum; (4) the first cost and maintenance should be commensurate with those of the prime mover so that the advantages of the prime mover will not be nullified by the transmission system; (5) the weight and space required should also be commensurate with that required of the prime movers for the reason just given; (6) if the torque characteristics of the prime mover do not coincide with the requirements of the propeller for all conditions of operation, then the transmission system must be capable of suitably adjusting to meet these requirements; (7) if the prime mover is not reversible then the transmission must provide this feature; (8) should it be possible to accidentally disconnect the propeller from the prime mover while under load it must be possible to re-establish the connection immediately. If this cannot be accomplished the consequences can be extremely serious and result in totally wrecked machinery; and (9) it is preferable that the transmission system selected for the merchant marine have a wide application to reduce development cost, simplify manning problems, and reduce maintenance.

There are available today many arrangements of marine transmission systems in successful operation with steam turbines which may be applied to the gas turbine. However, there is one important difference in the two prime movers, i.e., the steam turbine as it is known today is reversible and the gas turbine is not. Many suggestions and proposals have been made to provide a reversible gasturbine, but todate a reversible gas turbine has not been developed. In evaluating this factor, it should be apparent from the development of the reversible steam turbine that a number of difficult problems must be solved and that possibly many of these will not be adequately foreseen.




NOVEL METHOD OF REVERSING GAS-TURBINE POWER PLANT

(System consists of compressor turbine and power turbine and provides for the power turbine and compressor turbine to be in line and connected by an electric coupling that is not energized when going ahead. The rotation of the compressor turbine is the reverse of the power turbine. To reverse machine the power turbine is by-passed and the electric coupling energized permitting the compressor turbine to drive the propeller in reverse direction through the power turbine.)

The following transmission systems, presently available, might be considered as possible solutions to the problem: (1) Electric drive, direct current; (2) electric drive, alternating current; (3) mechanical geared drive with controllable-pitch propeller; (4) mechanical geared drive containing reversing features; and (5) mechanical geared drive with reversing gas turbine.

The various aspects of each of the foregoing transmission systems as it is known today in order to evaluate its possibilities for use with the gas-turbine power plant are thoroughly discussed.

It is concluded that the mechanical reduction-gear transmission with a controllable and reversible pitch propeller represents the best solution to the problem considering the extent of application, i.e., it is suitable with any gas-turbine power-plant arrangement, and its economic standing, simplicity of control, efficiency, maintenance, and reliability are satisfactory.

For limited application, the alternating-current electric drive and the mechanical reversing gears both offer acceptable solutions, in addition to the mechanical reduction gear with controllable pitch propeller.

Tables, photographs, and diagrams are included.

**The Universal Optimum Power Cycle for Elastic Fluid Turbine Power Plants,** by John Kreitner, American Hydromath Company, New York, N. Y., and Frederick Nettel, Mem. ASME, Manhasset, N. Y. 1947 ASME Annual Meeting paper No. 47—A-43 (mimeographed).

Basic thermodynamic investigations are reported for the combustion turbine, under which is included the gas turbine, leading to a new general theoretical heat cycle called the "Hexagon Cycle," of which the Brayton, Ericsson, and even the Carnot cycles are shown to be special cases. It thus forms the basis of what may be called a "General Cycle Theory" in which all so far known cycles lose their individual identity.

The general reasoning is indicated as follows, as applied, for example, to the compression phase of a heat cycle: In gas compression it is known that intercooling between stages of compression reduces the power consumption of the compressor. Any bit of intercooling helps wherever it is done, and intercooling between all individual stages of a multistage compressor represents the closest practical approach to isothermal compression which, since it leads to the minimum in compression work, has been generally accepted as best also for combustion-turbine plants.

In a combustion-turbine plant, however, the gas must be heated immediately after compression. Extending intercooling up to the last stage of compression or near to it, as is being practiced, means cooling the air where heat is an asset. Such cooling reduces compression work by just a trifle, but harms the over-all cycle efficiency by much more, because every heat unit carried away by the cooling water immediately afterward must be replaced by fuel heat.

It thus becomes clear that intercooling, when applied to a compressor forming part of a combustion-turbine plant, must follow requirements which are quite different from those when the compressor is considered by itself, i.e., when production of compressed gas or air is the sole object. Intercooling in a combustion-turbine plant to a constant cooling temperature has widely different effects depending on where it is applied. Near the compressor intake it helps the cycle as a whole, but to a very small degree, because very little compression heat is produced which can be carried off. Further on, the benefit of local intercooling increases from stage to stage, until at about one third of the total pressure ratio it reaches a maximum, whereafter the benefit begins to decline. At approximately two thirds of the total pressure ratio, benefit changes to detriment, and

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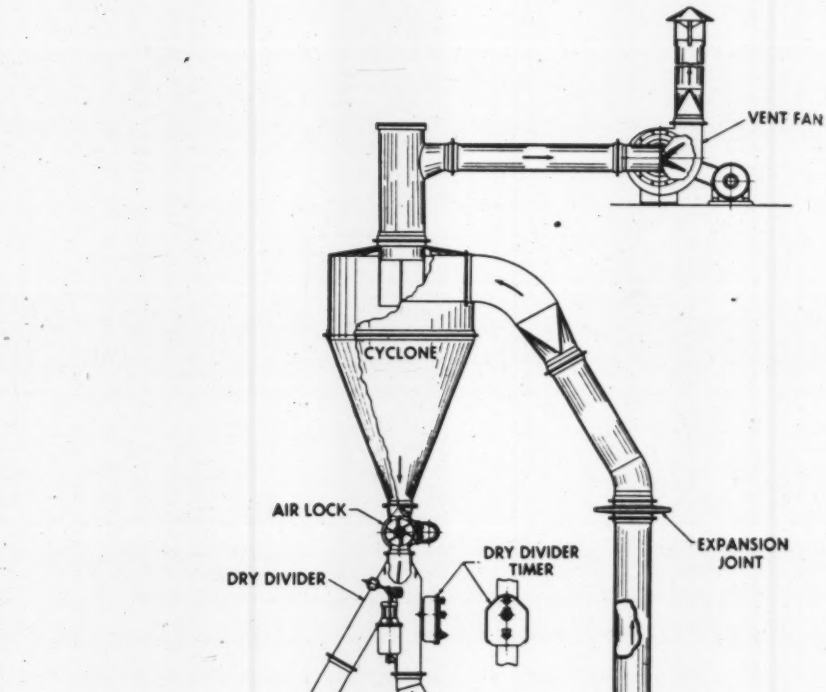
within the last third of compression any intercooling harms the cycle efficiency; the further on the more. The reason is that the small saving in compression work obtainable in the few last stages past the intercooler is outweighed by the increase in fuel input necessary to make up for the too-late cooling. The exact location of the points referred to as at approximately one third and two thirds of the total pressure ratio can be shown to depend on the other data selected for the power cycle, including also the size, or rather effectiveness, of a heat exchanger, if such is employed.

It follows that we have to forego cooling throughout all of the compression as contradictory to the thermal principles of the cycle, and to concentrate intercooling at one or several points, or within a stretch, where its advantage is greatest. Calculation shows that much greater benefit for the cycle as a whole can be derived from one or more intercoolers of a certain given heat-rejecting capacity if they are placed near the optimum point, than by spreading the same intercooler capacity out over the entire compression range.

Similar considerations have been made also for reheating of the working fluid during expansion. Also, here it was found that the conception to approach isothermal expansion in so far as possible, is detrimental to cycle efficiency, but that also reheating should be carefully coordinated with all other steps and measures adopted for the particular power cycle to furnish optimal results.

The authors state that the investigation has brought out the novel realization that there exists, so to speak, between the Brayton and the Ericsson, another cycle—the Hexagon Cycle—which requires less intercooling and reheating than the Ericsson cycle, yet is superior to both the Brayton and the Ericsson cycle.




FLASH-DRYING SYSTEM FOR DRYING FILTER CAKES

# Flash Drying

**Flash Drying of Materials by a New Method,** by Charles W. Gordon, Combustion Engineering Company, Inc., New York, N. Y. 1947 ASME Annual Meeting paper No. 47—A-97 (mimeographed).

Flash drying is the practically instantaneous removal of moisture from materials by the application of heat in a turbulent stream of hot air. Flash-drying systems were developed to cover the field of dried materials required in final particle size from fine to granular. The material is in contact with the drying air from one to ten seconds, depending upon the design requirements.

There are four fundamental factors which govern moisture evaporation by heat. They are: moisture dispersion, temperature differential, agitation, and particle size.

Flash drying is an application of the general principle of drying by vaporization into air. The operation is substantially adiabatic.

The systems are designed to operate under the following three distinct conditions: Drying without disintegration, drying with disintegration, and drying and pulverizing.

Typical applications of the three types are as follows:

Drying without disintegration: Coal (3/8 in. and smaller), amine crystals, sodium chloride, ammonium sulphate, potassium persulphate, wheat flour, and wood flour.

Drying with disintegration: Corn gluten meal, corn gluten feed, distillers' spent grain, brewers' spent grain, sewage sludge, packing-house sludge, clay, calcium-carbonate sludge, and filter cakes.

Drying and pulverizing: Clay, diatomaceous earth, copper sulphate, gypsum, steamed bone, aluminum stearate, potassium nitrate, strontium nitrate, colors and dyes, and vinyl resins.

The principal elements of the system are as follows: (1) Air heater—direct or indirect steam; gas, oil, or coal fired; (2) wet feeder—roll or conveyer; (3)

mixer—high or low speed; (4) agitator—cage or imp mill; (5) collection system—cyclone, air piping, and fan; (6) dry divider; (7) cooling and transport system—cyclone, air piping, and fan; (8) instruments and controls.

Some flash-drying systems require all of the foregoing elements, while others omit one or more of them. Typical examples of the three general classifications are illustrated by diagrammatic flow sheets, following a general description of the operation of flash-drying systems.

# Gas-Turbine Heat-Exchanger Design

**Test Results of High-Performance Heat-Exchanger Surfaces Used in Aircraft Intercoolers and Their Significance for Gas-Turbine Regenerator Design,** by A. L. London, Stanford University, Calif., and C. K. Ferguson, University of California, Berkeley, Calif. 1947 ASME Annual Meeting paper No. 47—A-83 (mimeographed).

This paper presents basic heat-transfer and flow-friction design data for a plate louvered-fin type of extended surface which may be of use in the gas-turbine-plant regenerator application. Different surfaces are compared on the basis of a heat-transfer-coefficient vs. friction-horsepower plot, and some of the heat-transfer and flow-friction aspects of regenerator design are discussed.

For a high-efficiency plant with good fuel economy over a wide load range it is necessary to use a regenerator of high effectiveness and consequently of large specific surface area, of the magnitude of 3 to 4 sq ft per shp. This is several times the transfer area requirement of the boiler plus condenser of a steam power plant. It is therefore evident that for a compact gas-turbine plant incorporating a high effectiveness regenerator it will be necessary to use types of exchanger surfaces having a substantially larger area to volume ratio than conventionally used in boiler- and condenser-tube banks. This requirement directs attention to the use of either very small circular tubes, ¼ in. in diameter or smaller, or extended surfaces. In the latter case extended surface on both air and gas sides will probably be desirable in that heat-transfer resistances on both sides are of comparable magnitudes.

Of possible use in the regenerator application are some of the extended surfaces developed for aircraft intercoolers. However, in order to evaluate the possibilities of these and other developmental types of "high-rating" surfaces, it is necessary that basic heat-transfer and flow-friction design data be obtained, and that these data be of an accuracy comparable to that available in the literature for flow normal to circular-tube bundles and for flow inside tubes. This lack of data has tended to channel the current regenerator developments toward the use of the shell-and-tube type of surface.

The U. S. Navy Bureau of Ships started a program aimed at this objective in 1945. The Office of Naval Research, in conjunction with the Bureaus of Ships and Aeronautics, is furthering this work on research contracts. The basic design data summarized in this paper represent the first results of this program. An additional objective of the paper is to consider some of the heat-transfer and flow-friction aspects of regenerator design.

The paper includes a description of the apparatus and tests, summary of test results, and a discussion of test results.

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**Heat-Exchanger Tube-Sheet Design,** by Karl A. Gardner, Mem. ASME, The Griscom-Russell Company, New York, N. Y. 1947 ASME Annual Meeting paper No. 47—A-104 (mimeographed).

A semitheoretical method for the design of circular tube sheets is outlined, based on "deflection and ligament efficiencies." These are roughly known from past experience with other design formulas, but experimental work is advocated for more accurate evaluation. A bayonet or U-tube sheet is considered as a modified solid plate and other types as modified solid plates on elastic foundations (the tubes themselves).

Presently used empirical design equations result in heat-exchanger tube sheets which are satisfactory under hydrostatic test and in service. They do not, however, take into account several factors which may be expected to have an influence on tube-sheet stresses. By regarding a tube sheet as a homogenous plate resting on an elastic foundation (except for U-tube or bayonet-tube exchangers) and subjected to a uniform hydrostatic pressure, equations for effective pressure distribution, deflection, bending moment, and stress, shear, and slope, have been derived. These involve a "deflection efficiency" and a "ligament efficiency," both requiring experimental determination for various tube gages, diameters, and pitches.

Several other factors entering into the state of stress in heat-exchanger tube sheets which are not covered in this paper and which eventually may have to be integrated with this work are as follows: Residual stresses in tubes and tube sheets due to tube expansion (rolling or drifting); thermal stresses caused by temperature gradient between tube-sheet faces in operation; thermal stresses due to temperature differential between tubes of different passes and between segments of multipass tube sheets; and possible loss or irregularity of tube-sheet support in service by corroded, eroded, bent, or otherwise damaged tubes.

The paper constitutes an introduction to tube-sheet design covering only the simpler cases. The same basic equations are applicable to other types of tube sheet, such as those integral with the supporting member or those subjected to additional bending moments by bolting around the periphery and, by modification, to those receiving support from stays or partitions in the heads.

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**A Design Method for Counterflow Shell-and-Tube Heat Exchangers for Gas Turbines,** by D. G. Shepherd, A. V. Roe Canada Ltd., Toronto, Ont., Can. 1947 ASME Annual Meeting paper No. 47—A-60 (mimeographed).

The design data for heat transfer and pressure loss in conventional shell-and-tube heat exchangers are well-established but owing to the number of variables their application to gas-turbine work often requires a considerable amount of tedious calculation to obtain the optimum design or a range of designs to suit possible variations in the layout of the plant. This paper presents a procedure by which a few calculations provide a series of graphs covering a wide range of possible designs, varying in number of tubes, length of tubes, spacing, and total surface area. It is based on a constant loss of specific horsepower rather than on fixed air- and gas-pressure losses and takes tube pitch as the independent variable.

Mathematical expressions for pressure drop, heat transfer, and tube arrangement are developed. These relations are shown to be sufficient to establish a unique solution for a given value of the pitch-diameter ratio. A series of about six calculations, each for a different value of pitch-diameter ratio, varying from 1.2 to 1.7, are required to obtain data from which four curves are drawn. The procedure is outlined step by step.

The calculations show that for a given set of cycle conditions there is a certain tube-pitch ratio which gives the minimum surface area. Other expressions are developed which allow rapid calculations of the initial design of intercoolers of 95 per cent thermal ratio. The method of obtaining the specific power

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loss of a gas turbine due to pressure losses in the heat exchanger is outlined in an appendix.

The paper presents no new data. While the results of the method are not of sufficient accuracy for final design, the results do enable the designer to define the complete range of possible designs with a minimum of calculation.

# Wood Industries

**Results of Accelerated Tests and Long-Term Exposures on Glue Joints in Laminated Beams,** by T. R. Truax and M. L. Selbo, Forest Products Laboratory, Madison, Wis. 1947 ASME Annual Meeting paper No. 47—A-85 (mimeographed; to be published in Trans. ASME).

A rapid method developed at the U. S. Forest Products Laboratory for determining the durability of glue joints in laminated beams intended for exterior service is described. The test is based on the principle that severe shrinking and swelling of laminated members produce stresses that cause checking of wood, failure of glue joints, or both. Vacuum and pressure are employed in bringing about the desired conditions of shrinking and swelling.

Laminating for exterior use, like many other major developments, was prompted by an urgent need in time of war. The Navy needed immense numbers of ships and boats, the building of which soon brought on a shortage of available materials. White oak, the foremost shipbuilding species, seasons slowly, especially in large dimensions. Nominal one-inch oak lumber, however, can be dried in a relatively short time. A process was therefore developed whereby boat and ship timbers of the desired shapes and sizes, and timbers for other exterior uses were laminated from kiln-dried lumber with intermediate temperature-setting phenol and later with resorcinol-resin glues.

In exterior use timbers are subjected to wetting and drying that cause severe stresses and a tendency to check. In laminated timbers these stresses are more or less concentrated at the glue lines. In addition, the laminations are usually relatively thick in comparison with veneer used for plywood, and the requirements on glue-line performance are even more rigid than in exterior plywood. Hence accelerated tests that accurately predict the durability of laminated members under exterior exposure are of considerable importance.

The work of the U. S. Forest Products Laboratory on test procedures and test methods deals exclusively with types of glues, such as phenol, melamine, and resorcinol resins that, when properly used, have been found durable in exterior service.

During service, timbers used for exterior purposes may be expected to undergo considerable change in moisture content. To furnish dependable test results, stresses similar to those that might occur in service must therefore be induced during the test and, furthermore, the possible leaching or solvent effect of moisture upon the glue must be simulated. The two accelerated tests, described in the paper, were intended to simulate these conditions.

Results of the test are correlated with more extended laboratory exposures and with long-term soaking and weathering.

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**Radio-Frequency Heating in the Woodworking Industry,** by F. L. Macaluso, Jun. ASME, Westinghouse Electric Corporation, Baltimore, Md. 1947 ASME Annual Meeting paper No. 47—A-115 (mimeographed; to be published in Trans. ASME).

Radio-frequency heating is finding wide application in the woodworking industry for such processes as edge-gluing, plywood manufacture, drying, and assembly-gluing. The theory of radio-frequency heating is reviewed and how this type of heat is applied in various applications is described. Several case histories of actual manufacturing problems are discussed. The recent Federal Communications Commission Regulations on the use of radio-frequency power for industrial heating are treated comprehensively.

Electric heating is accomplished by passing a current through the piece to be heated and the value of this current squared times the resistance of the piece is the power.

To heat a pound of wood, a 1 × 6-in. board 8 in. long, with a 60-cycle current and with electrodes on the 6 × 8-in. faces requires approximately $2^1/_4$ million volts and 0.027 amp. This high voltage is extremely impractical.

Using a radio frequency of 13.6 megacycles, this heating can be accomplished with 2100 volts and 5.8 amp, which are entirely reasonable figures for RF heating.

One of the first commercially successful applications of RF heating in the woodworking industry was in the manufacture of plywood.

The manufacture of curved plywood is considerably more favorable for RF heating than the manufacture of large flat panels, particularly on short runs, since curved wooden forms covered with thin metal electrodes are much more economical than curved metal forms with heating elements.

The most important commercial application of RF heating in the woodworking industry today, appears to be that of edge-gluing narrow boards to fabricate core stock or large open-face panels. The general practice is to glue several pieces from 2 to 4 in. wide and 1 in. thick into panels as large as 48 × 96 in.

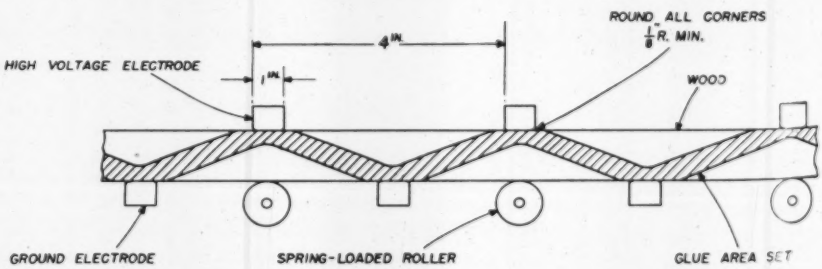
Using this process, 36 × 96-in. boards made of 1 × 3-in. pieces have been satisfactorily glued in 20 sec and less, using a 10-kw RF generator.

Although practically all RF heating for edge-gluing wood is done today with batch-type presses, a continuous RF edge-gluing press has recently been developed which tests indicated will produce at greater rates than the batch press.

The use of RF power for edge-gluing affords particularly noteworthy savings since it is said to eliminate the cumbersome carrier clamps requiring many operators, saves considerable manufacturing and storage space, permits the use of high-temperature setting and highly water-resistant glues, permits a glue saving of as much as 50 per cent in some operations, and makes for greater uniformity with less rejects.

A number of resin glues are now on the market which are very satisfactory for this type of heating. In general, the urea, resorcinol, and melamine glues are satisfactory while the alkaline phenolic glues are not.

One of the most interesting applications of RF heating in the woodworking




DIAGRAMMATIC DRAWING OF CONTINUOUS EDGE-GLUING PRESS

industry is that of assembly gluing for the manufacture of items such as radio cabinets, clock cases, and sewing cabinets. With a little experience the design of the jigs and clamps, location of the electrodes, and selection of the proper generating rating and frequency are relatively simple.

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**Performance Characteristics of Tight Oak-Laminated Stave and Solid-Stave Barrels,** by R. S. Kurtenacker, Forest Products Laboratory, Madison, Wis., and D. L., Patrick, General Plywood Corporation, Louisville, Ky. 1947 ASME Annual Meeting paper No. **47—A-127** (mimeographed; to be published in Trans. ASME).

The glued laminated wooden arch, which in the last ten years has found popular acceptance in the building industry, has recently found application in the construction of barrels. This is, perhaps, one of the most drastic changes made in barrel design in many decades. Although great progress has been made in developing and improving mechanical devices for fabricating barrels, the general features of construction have remained unchanged. The use of laminated staves, together with plywood heads, results in an entirely new style of construction for which certain advantages are claimed. Such barrels, as well as barrels made of solid wood staves and heads, were the subject of a study at the U. S. Forest Products Laboratory, Madison, Wis.

The investigation was made in cooperation with the General Plywood Corporation, Louisville, Ky. The purpose of the investigation was to study the performance characteristics of tight barrels of two constructions. One consisted of laminated staves and plywood heads while the other was of solid staves and multiple-piece heads. Both barrels were made of white oak. Their construction and the test results obtained are described.

One advantage noted in the laminated barrels was that they were apparently not subject to wormholes as were the older type.

The laminated staves were made of four layers of $^3/_{16}$-in-thick, rotary-cut, white oak veneer laminated together with a phenol-resin glue. The finished staves were about $^3/_4$ in. thick and averaged $34^7/_8$ in. in length. The heads were of five plies of $^3/_{16}$-in-thick, rotary cut, also bonded with phenol-resin glue. Finished, they were $^{15}/_{16}$ in. thick.

The barrels, of about 50 gal capacity, were filled with water for the tests.

A compression test on bilge in a 25,000-lb-capacity universal testing machine revealed that the laminated-stave barrels sustained greater average maximum loads and with less distortion than the solid-stave barrels.

LAMINATED-STAVE, PLYWOOD-HEAD BARREL ARRANGED IN 25,000-LB TESTING MACHINE FOR COMPRESSION TEST ON BILGE

Drop tests revealed that the laminated-stave barrels withstood average maximum drop heights of 48 to 51 in., while the solid-stave barrels withstood average maximum drop heights of 24 to 27 in.

In the internal hydrostatic pressure test, the laminated-stave barrels withstood greater internal pressures and also exhibited greater tightness.

Tests did not indicate the adaptability of the barrels for aging of alcoholic beverages.

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**Wetting Agents in Forestry Fire Fighting,** by Hugh McNair and James J. Duggan, Carbide and Carbon Chemicals Corporation, New York, N. Y. 1947 ASME Annual Meeting paper No. **47—A-92** (mimeographed).

A newly developed concentration of organic chemicals of such extremely fast penetrating action that when added to water in small amounts, increases the extinguishing action of the water 200 to 400 per cent, is described. The action of the penetrant and results of preliminary tests are also reported.

Water impregnated with such wetting agents is known to chemists as "wet water."

The new penetrant, known as "Unox," was used with considerable success in recent extensive forest fires on the east coast.

Normal use calls for one part of the penetrant to 100 parts of water; in some cases less. Although it cannot be purchased for a few cents a gallon, the cost becomes small when evaluated in terms of dollars saved through more efficient fire fighting.

While such fire-extinguishing agents are still in a somewhat experimental stage, they promise a new chapter in fighting fires.

Chemical substitutes for water are effective in certain types of fires but water is and probably always will be the chief weapon due to its economy and availability. Therefore the greatest contribution that chemistry can make will be not to offer a substitute for water, but to increase the extinguishing action of water itself.

While water is potentially an efficient extinguishing agent, in practice it is relatively inefficient owing to the inability to bring it into immediate or prolonged contact with the heat that must be absorbed to put out the fire. For instance, in a large building fire, thousands of gallons of water may be poured on without apparent effect, because only a small proportion of the water is actually reaching the heat.

This heat is in the burning material and the water, to be effective, must penetrate the material to whatever depth the temperature is high enough to cause decomposition of the solid matter into gases. Any means of increasing the speed with which water will penetrate the charred surface will increase its efficiency.

The wetting agent, or penetrant, performs this function, because of its ability

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to penetrate porous materials which plain water will not penetrate, or will penetrate slowly, such as char and wood, cotton and kapok.

Another characteristic of the wetting agent is its ability to spread and creep over a surface. Tests using water to protect metal surfaces, such as storage tanks, from radiated heat indicate that when a wetting agent is present in the water, the cooling efficiency is increased by as much as 50 per cent.

A report of a test of the new penetrant by the U. S. Forest Service in Virginia indicated that on mop-up operations where a solution of $^1/_2$ per cent was used, an average of $^1/_2$ gal of solution per stump was required for complete extinguishment, with no rekindling. When plain water was used, an average of $1^1/_4$ gal was used per stump, with 95 per cent rekindle.

The penetrant also has been used by municipal fire departments. It was indicated that on the average building fire, extinguishment can be effected more rapidly with 3 to 5 times less water. In every case there has been a marked reduction in smoke generation and water damage was practically eliminated.

Large-scale experiments have been conducted with burning bales of cotton and paper and the ratio of efficiency was much higher than for plain water.

# Improving Availability of Steam Motive Power

THE following five papers contributed by representatives of coal producers, railroad operators, and railroad-equipment manufacturers constitute a symposium on the subject of what can be done to reverse the present trend away from the coal-burning locomotive. A general confidence in the future of coal in the railroad industry permeates the papers, as well as an awareness of the need for research and industry-wide co-operation in the standardization of coal and locomotive design to equal or better the economy of Diesel competition.

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**Regional Standards for Locomotive Fuel,** by Earl C. Payne, Mem ASME, Pittsburgh Consolidation Coal Company, Pittsburgh, Pa. 1947 ASME Annual Meeting paper No. 47—A-47 (mimeographed).

In view of the shortage of liquid fuel supply and the recent development of oil-consuming defensive weapons, and especially the unrealistic expansion of Diesel motive power and domestic oil heating, the trend away from the coal-burning locomotive is jeopardizing the national defense. If the trend continues unbridled, the railroads which carried the major transportation burden during the last war, will find themselves immobile at the moment liquid fuels are diverted to purposes of national defense.

The time has arrived for fuel planning on a national scale. A National Fuel Planning Board might be formed under the Secretary of the Interior, composed of representatives of the petroleum, gas, coal, and synthetic-fuel industries to formulate a fuel policy in the public interest.

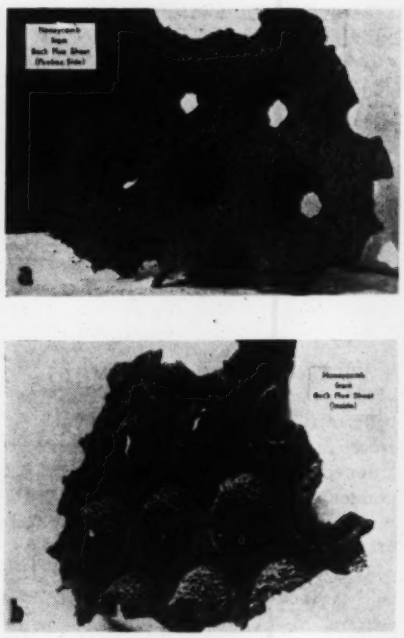
Railroad men are of the general opinion that the coal industry can best help to improve the competitive position of coal-burning locomotives by making available coal of a better and more uniform quality at low prices. Cognizance of this need has caused the coal industry to invest heavily in underground mechanization. Individually and jointly, coal producers are investigating revolutionary mining methods to keep costs of locomotive fuels low.

Unfortunately, underground mechanization results in higher ash, wider quality variations, and increased percentages of fine slack sizes, that is, the kind of coal that the railroad industry tries to avoid. Mechanization means a tremendous additional investment in cleaning and preparation equipment if the product is to meet the needs of the railroads.

But these handicaps can be overcome and low-cost quality tonnage can be achieved if the railroads agree on a long-range fuel-planning program and a stable supply relationship which can eliminate the uncertainty, on one hand, of available supply and on the other, of a sustained demand for a particular type of suitable fuel.

The success of such an agreement will rest on test information to remove differences of opinion on what the proper coal from each mine should be for use on road railroads and on the refusal of producers to ship and users to accept coal designated as unsuitable.

The nation is at a turning point in a century of progress with steam motive power. There must be patience, understanding, and intelligence in the continued use of solid fuels. Failure to coordinate supply and demand of all fuels can lead only to chaos.



SLAG PRIED OFF REAR FLUE SHEET AFTER LESS THAN 100 MILES USING WRONG FUEL

(*a*, firebox side; *b*, flue sheet side of same piece.)

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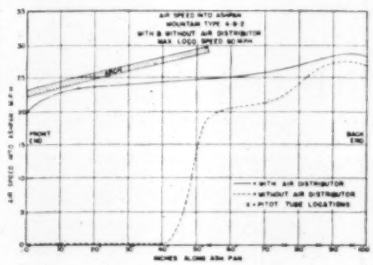
**Locomotive Firebox and Boiler Performance,** by Fred D. Mosher, Mem. ASME, The Standard Stoker Company, Inc., Erie, Pa. 1947 ASME Annual Meeting paper No. 47—A-48 (mimeographed).

The reciprocating coal-fired steam locomotive of 1947 is essentially the same as its counterpart of 50 years ago. Gains have been made through the adoption of improved combustion chambers, feedwater heaters and pumps, improved brick arches, water circulation through firebox, mechanical firing equipment, and the use of superheaters and steam driers. Boilers have become larger and steam pressures higher but because of the service restrictions which have limited the freedom of designers, locomotive structure has undergone only slight alteration.

Hindering progress is the lack of a satisfactory method of predicting locomotive performance. The Cole ratios, now 30 years old and generally inadequate, need to be replaced by locomotive test data upon which a rational method of modern locomotive design can be formulated.

The greatest opportunities for increasing useful locomotive horsepower lie in improvements in boilers and fireboxes. Other opportunities lie in improvement in the distribution of combustion air for the ability of the conventional steam locomotive to provide air for burning of



VELOCITY PATTERN OF AIR FLOW TO THE FIREBOX WITH AND WITHOUT AN AIR DISTRIBUTOR

its fuel determines its capacity as a steam generator. Because the effect of speed in a locomotive boiler is to pile the air at the back portion of the ashpan so that velocities through the grates at this location are much greater than at the front portion, unbalanced burning of coal on the grates results. Tests have shown that when undergrate air velocities are redistributed by use of baffles, reductions in coal consumption ranging from 7 to 15 per cent depending on the design of locomotive can be obtained.

Further economies lie in better methods of moving combustion air and exhausting gases of combustion from the front end of the locomotive. Back-pressure horsepower now used for this purpose may be as much as one third of the total power output of the locomotive. Only by eliminating the exhaust nozzle can back-pressure be reduced to a minimum. A successful development of a mechanical draft system would add in the order of 15 to 20 per cent to drawbar horsepower. Admission of secondary air has been tried, but while there is no general agreement on results, some justification for this technique can be found where objectionable smoke is a problem.

Recent introduction of poppet valves on locomotives of modern design has helped to set a new world's record for sustained monthly mileage.

Industry-wide co-operation among the railroads, coal producers, and equipment manufacturers augurs well for the reciprocation coal-burning locomotive. The program for the future should include pooling of knowledge and financial support to provide facilities for experimental work.

Research into use of higher pressures, possibility of the application of the coal-burning cyclone furnace to the locomotive, better combustion techniques utilizing improved handling and distribution of air, and use of better materials, all promise working information which will help to improve availability of steam motive power.

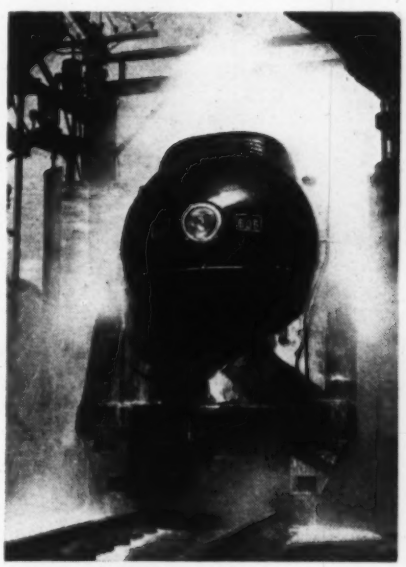
**Better Locomotive Servicing Facilities on the Norfolk and Western Railway,** by C. E. Pond, Mem. ASME, Norfolk and Western Railway Company, Roanoke, Va. 1947 ASME Annual Meeting paper No. 47—A-49 (mimeographed).

Availability and utilization of the coal-burning reciprocating steam locomotive can be increased by providing better locomotive servicing facilities. New and improved service machinery can challenge higher wages and increased materials costs by increasing productivity per man-hour.

In the last 20 years the Norfolk and Western Railway Company has increased its investment per employee in service facilities approximately 100 per cent. This paper describes the new servicing facilities installed at Williamson, W. Va. The major units consist of a three-track concrete engine-washing platform, combined with hydraulic ash-handling facilities, and a twin-track engine-servicing building, with two 135-ft inspection pits. The terminal, with a normal dispatchment of 60 locomotives, has a capacity of 80 locomotives daily.

These improved facilities have increased locomotive availability by reducing turning time, increased terminal capacity, and lower cost of handling locomotives. It has enabled the same working force to dispatch 20 per cent more locomotives. Class A locomotives are regularly turned in one hour.

Another example of increasing productivity per man is the installation of a rotation-nozzle locomotive-machinery washer which permits three men to do a better washing job than could be done by a shift of eight men.



LOCOMOTIVE ENTERING WASHER AT THE WILLIAMSON TERMINAL

Eleven illustrations showing improved servicing facilities at the Williamson terminal are included.

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**Intensive Utilization of Coal-Fired Steam Locomotives,** by E. L. Johnson, New York Central System, New York, N. Y. 1947 ASME Annual Meeting paper No. 47—A-50 (mimeographed).

Utilization is one of the fundamental factors upon which relative values of different types of motive power may be predicated. Other factors are over-all cost of ownership and usage, performance efficiency, and versatility for work.

To achieve high utilization a locomotive must be designed for continuity of operation on the road. This depends on reduced delays chargeable to the locomotive itself and expeditious handling of trains on established schedules, two factors which introduce possibilities for improving schedules without increasing current maximum operating speeds. Benefits which may be obtained from improvements in right-of-way and operating practices also depend on the ability of the locomotive to support high-utilization demands.

Progress made during the last 20 years by the New York Central System in the design of the reciprocating steam locomotive are incorporated in the Class S, 4-8-4 "Niagara"-type locomotive, first placed in service in March, 1945. These locomotives represent increases in capacity and size made necessary by demands for higher speeds and heavier trains, a 30 per cent reduction in engine weight per indicated horsepower, and a 100 per cent increase in drawbar pull and horsepower.

The principal characteristics of progressive locomotive designs developed by the New York Central System are given in the paper.

To compare the Niagara potentialities in passenger-train duty with those of Diesel-electric locomotives of the 4000-hp two-unit type, a series of tests were conducted in 1946 and 1947 over a route between Chicago and Harmon, Ill. Comparative data were obtained for availability utilization under favorable conditions.

To insure the utmost continuity of operation during the tests, terminal forces were organized to provide co-operation between supply facilities and maintenance forces to see that unit assemblies were available for repair work.

Table 1 shows the actual and potential mileage that may be anticipated for the Niagara when assigned to attain maximum continuity of operation with the resulting high utilization in comparison

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with the mileage that may be anticipated when assigned to pooled main-line service. A comparison is also made with the mileage of Diesels when receiving preferred attention and assigned to the more important trains.

TABLE 1 ACTUAL AND POTENTIAL MONTHLY MILEAGE COMPARISON BETWEEN NIAGARAS AND DIESELS

| | Monthly Mileage — Actual average | Monthly Mileage — Evaluated potential (12-month cycle) |
|---|---|---|
| Niagaras assigned to obtain maximum continuity of operation | 26,168 (2-month period) | 22,750 |
| Niagaras assigned to pooled main-line service | 15,960 (6-month period) | 16,334 |
| Diesels assigned to obtain maximum continuity of operation | 28,307 (6-month period) | 27,000 |

While the performance of the Diesels was exceptional, no data are available on repair costs because all the Diesels used in the tests were new with an average age of 10 months for 32 units. Based on current terminal repairs for Diesels, these costs may be expected to follow a pattern not unlike that for the reciprocating steam locomotives. The total repair costs, when obtained, will be a basic factor in determining the over-all economy of the Diesels as compared with the Niagara locomotives.

Intensive utilization performance of the Niagaras compared with pooled service represents an increase of 39 per cent and is only 16 per cent less than the potential mileage for its Diesel competitor assigned on runs producing maximum continuity of operation. This increase is mainly attributed to concentrated and co-operative effort to increase utilization of a locomotive designed for such service. The utilization may be further improved and the difference between the steam and the Diesel may be narrowed by further co-operative and supervised effort as well as taking advantage of improved materials, maintenance practices, and servicing facilities. Comparison of performance of the Niagaras with passenger locomotives of not too many years ago, when the car miles per locomotive mile were only about half of the present and the average monthly mileage for the highest mileage locomotive was less than 10,000, indicates that progress in the design, operation, and maintenance of the reciprocating steam locomotive is being attained.

**Developments and Trends in Coal-Burning Locomotives,** by Charles Kerr, Jr., Westinghouse Electric Corporation, East Pittsburgh, Pa. 1947 ASME Annual Meeting paper No. **47—A-51** (mimeographed).

Designers of tomorrow's coal-burning motive power will have a choice of the following types: reciprocating locomotive, steam-turbine locomotive with mechanical or electrical transmission, and probably the gas-turbine locomotive with mechanical or electrical transmission. Widespread acceptance of any of these types will rest largely on their ability to equal or better operating performance, availability, first cost, and operating economy of oil-fired competition now represented by the Diesel and, in the near future, by the gas turbine.

The reciprocating locomotive with its concentration of power in a single unit, may anticipate the future with confidence because of current development projects which seek to improve performance by introduction of induced draft, cinder-cleaning front ends, poppet valves, and better combustion air distribution.

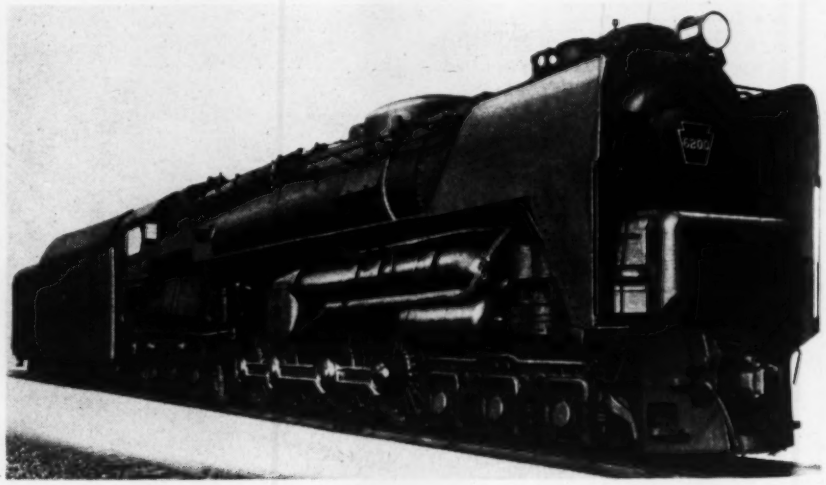
Having handled all assigned runs with ease, the geared steam-turbine locomotive which made its appearance in 1944, has satisfied the basic prerequisite necessary for further extensive exploitation of the geared-turbine principle. The speed-tractive effort characteristics of this locomotive are the best of any known prime mover for traction purposes. Although capacity of the boiler is now a limiting factor, the success of the steam turbine can be expected to hasten progress in higher steam pressures and temperatures and lower back pressures.

Use of electric transmission on the steam-turbine locomotive offers, among other advantages, the ability to distribute power over a large number of axles, to mount the prime mover in the main cab completely disassociated from the driving axles, and to deliver at the rails a constant horsepower over the normal speed range of the locomotive. Such a unit has recently been completed but operating results are not yet available.

A pioneer gas-turbine locomotive may be on the rails in 1948 or 1949 but the art is too new to expect proved commercial models to follow immediately in volume production. From a long-range point of view, these locomotives offer many advantages such as elimination of the boiler, elimination of reciprocating machinery, and substitution of purely rotating apparatus with its low maintenance cost and long periods of service without attention, excellent weight and space characteristics, and finally, high efficiency while burning low-cost fuels.

The one outstanding advantage of coal-burning locomotives in their bid for popular acceptance is the use of coal, but in recent years it has been shown that the use of coal alone is not sufficient to compete with the Diesel.

In the future, coal-burning locomotives will be more expensive. Standardization on one or two well-chosen models of universally applicable sizes with weight and clearance characteristics that will permit their purchase by any railroad, will help to keep cost down. An over-all fuel economy of 10 per cent must be designed into new units to overcome the current handicap of excess fuel cost. Such economy is impossible except through the use of higher temperatures and pressures, and lower back pressures. Steam-turbine locomotives with 600-lb steam pressure and 900 F temperature and with



PIONEER GEARED-TURBINE COAL-BURNING LOCOMOTIVE OF THE PENNSYLVANIA RAILROAD COMPANY PLACED IN SERVICE IN 1944

a 5- to 10-lb exhaust pressure will equal or better the desired goal of 10 per cent over-all efficiency.

If the gas turbine is perfected to burn coal the stigma of high fuel expense will no longer plague the coal-burning locomotive. With efficiencies of 18 to 20 per cent, or maybe eventually higher, gas turbines will operate at an over-all fuel expense considerably below any conceivable Diesel costs.

Future coal-burning motive power, whether reciprocating, steam turbine, or gas turbine, must be designed and built for greater standardization, improved availability, better fuel economy, lower operating cost, and greater operating flexibility. To produce such locomotives capable of holding their own in any competition should not be an impossible task if the concentrated efforts of all interested parties are put forth, backed by extensive development, and engineering skill of the highest order.

# Industrial Instruments

**Frequency-Response Measurements of a Hydraulic Power Unit,** by M. Russell Hannah, Sperry Gyroscope Company, Inc., Great Neck, N. Y. 1947 ASME Annual Meeting paper No. **47—A-70** (mimeographed; to be published in Trans. ASME).

Hydraulic power units continue to find many important applications in a wide variety of servomechanisms wherein high-performance power sources are required.

This report outlines an investigation into the dynamic response of a typical hydraulic power unit comprising a transmission and associated stroke control. The well-known tool of frequency analysis has been employed to investigate the effects of certain system parameters upon the performance of the several components of the power unit. The results have been evaluated with a view toward effecting improvement in the response of the power unit as a whole.

The basic measuring techniques described were first acquired in the Automatic Control Laboratory of the department of electrical engineering at the Massachusetts Institute of Technology, where considerable attention has been devoted to the study of hydraulic servomechanisms by means of alternating-current analysis.

The primary object of the investigation was to measure the dynamic response of a Vickers model AA-16850 aircraft duplex hydraulic power unit, each half of which consists essentially of a fixed-displacement axial-piston hydraulic motor (0.378 cu in. per revolution) supplied in either direction with oil under pressure from a variable-displacement axial-piston pump (0.319 cu in. per revolution max). The nominal rating of the transmission is approximately 4 hp. The displacement of the pump is controlled by a small hydraulic amplifier of which the pilot or control valve is positioned by means of a differential solenoid.

The response, not only of the power unit as a whole, but also of each of the elements making up the complete power unit were measured. These elements are the control solenoid, the hydraulic amplifier, and the hydraulic transmission.

It is shown that the over-all response of the transmission and stroke control can be represented by a linear, constant-coefficient differential equation of relatively low order. Further, the response of the various elements in the power unit has been measured and compared in order to assess the power merits of these elements in a servoloop and to provide a basis for the design of power amplifiers to be used to stroke larger transmissions. In addition, certain evidence has been established concerning the magnitudes of the effects of various parameters upon the dynamic behavior of the several elements in the power unit.

Topics such as technique of measurement, results of tests, analytic approximations, evaluation of results, and notes on procedure, are thoroughly discussed.

**Electrical System for Aircraft Flowmeters,** by R. G. Ballard, West Lynn Works, General Electric Company, West Lynn, Mass. 1947 ASME Annual Meeting paper No. **47—A-67** (mimeographed).

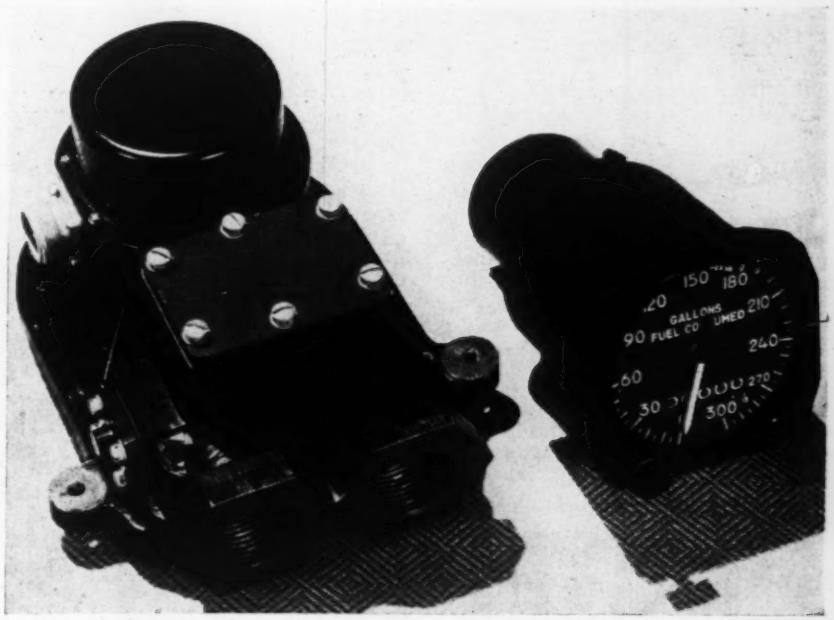
An electrical system for the remote indication of the rate of flow and totalized quantity of liquid is described. This system, consisting of a transmitter mounted on the metering device and a synchronous-motor-actuated indicator, provides pointer indication of rate of flow and cyclometer indication of total flow.

Power is obtained directly from a 12 or 24-volt direct-current supply and accuracy of indication is independent of normal supply voltage fluctuations. Either one or two cyclometers is provided; reset knobs are used to return the cyclometers to zero when desired.

The system works in conjunction with a positive displacement metering unit, wherein the speed of rotation of the output shaft is proportional to the volumetric rate of flow of fluid through the metering unit. A typical flowmeter includes an electric transmitter, which is a part of the pump mechanism, and an indicator.

The transmitter is normally actuated from the pump mechanism by means of a magnetic coupling, thereby preventing leakage of fuel and eliminating a possible fire hazard. Weight of the complete electric transmitter is less than 0.7 lb.

Range of indication is dependent only upon providing the proper gearing between the pump mechanism and the




TYPICAL FLOWMETER EQUIPMENT
(*Left*, transmitter; *right*, indicator.)

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shaft of the electric transmitter and correct gearing for cyclometer indication. Ranges which have been provided include 150, 300, 600, 1200, and 1500 gal per hr. Calibration may be in pounds instead of gallons when the pump mechanism is adjusted to register correctly for the specific gravity of fuel being metered. The complete flowmeter indicator weighs 2.2 lb.

Satisfactory operation throughout wide-temperature and voltage-supply variations have been obtained, while permitting the use of either one or two indicators without affecting the accuracy of totalization or rate-of-flow indication. Totalization accuracy was shown to be affected only by the pump-mechanism errors, and temperature errors affecting rate-of-flow indication were discussed. A trend toward smaller-size flowmeter indicators, with separate totalization, was indicated.

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**Stability of SR-4 Electric-Strain Gages and Methods for Their Waterproofing and Protection in Field Service,** by A. Boodberg, E. D. Howe, member ASME, and B. York, University of California, Los Angeles, Calif. 1947 ASME Annual Meeting paper No. 47—A-120 (mimeographed).

Tests of stability of SR-4 electric-strain gages at the University of California were undertaken as preliminary and supplementary studies to the investigation instituted by the Office of Scientific Research and Development into the History of Residual Stresses in Welded Ships, in February, 1944. The tests were conducted to determine the protective qualities and durability of waterproofing agents that could be conveniently applied to SR-4 gages which were to be installed on the decks of the ships used in the investigation.

The effects of time and service, changes in temperature, humidity, and methods of mounting were also studied, and as the test progressed it was decided to check the stability of certain SR-4 gage readings for a longer period of time. Most of the tests were conducted under static conditions on ship-plate blocks that were not subjected to loads, readings on the gages being taken daily during the first months of the investigation, and at less frequent intervals later.

Some results were obtained from bars equipped with SR-4 gages and subjected to various tensile and compressive loads at different times throughout the test period of more than 30 months.

The test results indicate that the SR-4 electric-strain gages, if properly waterproofed and well protected from mechanical damage, are reliable for a considerable length of time even under the most severe type of usage. The gages showed no indication of drift with time when well protected from moisture.

Of the several waterproofing agents tested, a combination of Petrosene A wax and Ozite B applied on the heated plate performed best for a long period of time.

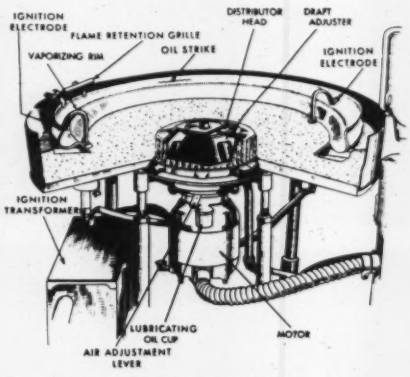
# Fuel-Oil Combustion

**Mechanisms of Combustion and Their Relation to Oil-Burner Design,** by H. R. Heiple and W. A. Sullivan, Shell Oil Company, Inc., New York, N. Y. 1947 ASME Annual Meeting paper No. 47—A-34 (in type; to be published in Trans. ASME).

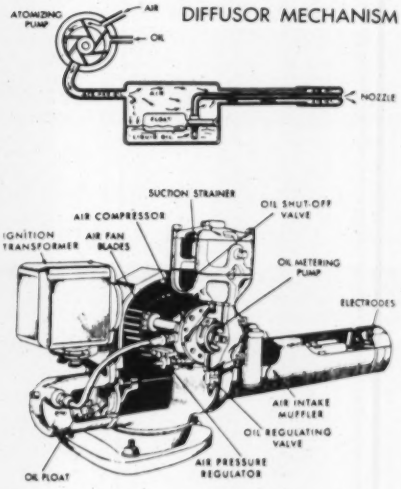
The combustion of fuel oils is a very complex process from the viewpoint of the kineticist. In any attempt to treat this subject theoretically the over-all process must be broken down into a group of consecutively and frequently concurrently occurring chemical and physical changes and each of these analyzed in turn. From an integration of the conclusions obtained by this means a more comprehensive conception of the factors involved in the burning of hydrocarbon fuel oils may be attained. In this paper an attempt is made to show what processes are involved, and means by which this information may be utilized in the design of burners are indicated.

Inasmuch as the chemical reaction wherein the oil unites with oxygen to liberate heat and combustion products is of primary interest, certain aspects of the kinetics of chemical reactions are discussed.

Chemical reactions occur by one of two mechanisms, namely, by a thermal or by a chain mechanism. In thermal reactions molecular species only are involved.




WALL FLAME-TYPE VAPORIZING BURNER




LOW-PRESSURE AIR-ATOMIZING GUN-TYPE OIL BURNER

In the second type of reaction mechanism, known as the chain mechanism, the initial reaction is invariably followed by a chain of successive reactions.

The oxidation of hydrocarbons, particularly of the gaseous and more volatile liquid hydrocarbons, has been studied extensively and has been shown to proceed by a chain mechanism.

Although the combustion mechanism is of such complexity that the processes involved have not yet been determined and set in order, an additional complication arises through the occurrence of a number of reactions involving only the hydrocarbon molecules. The reactions involved are those commonly designated as cracking, polymerization, and isomerization.

Certain physical and physicochemical properties of hydrocarbons and their mixtures are of considerable significance in their utilization as fuels. The most important of these are defined and their effect on oil-burner performance is discussed.

The devices that burn distillate fuel oils operate by either one of two methods. They vaporize the fuel, mix it with air, and burn the mixture, usually with the aid of secondary air; such burners are known as vaporizing burners; or they disperse the oil as fine droplets by some mechanical or hydraulic means and burn the mist of oil droplets after admixture with air; such burners are known as atomizing burners. Although considerable differences exist between individual burners, each can be classified in one or the other of these types. A discussion of the relation between burner design and combustion characteristics of fuels based on these two types is presented.

# Applied Mechanics

**Large Displacements With Small Strains in Loaded Structures,** by K. H. Swainger, Imperial College of Science and Technology, City and Guilds College, London, England. 1947 ASME Annual Meeting paper No. 47—A-29 (in type; published in the *Journal of Applied Mechanics*, March, 1948).

This paper considers the case of flexible structures in which displacements can be large although strains are small. The theory gives an "exact" solution in a large class of problems where the displacements are large but predictable closely from the physical conditions imposed. In this method, the major part of the displacement is "guessed," and then a further "small" displacement calculated from equations, which are developed, to assure compatibility. As a simple but not trivial example, the generation of an elastic cylinder from a flat plate is considered to illustrate the method.

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**The Bending of Symmetrically Loaded Circular Plates of Variable Thickness,** by H. D. Conway. Cornell University, Ithaca, N. Y. 1947 ASME Annual Meeting paper No. 47—A-35 (in type; published in the *Journal of Applied Mechanics*, March, 1948).

This investigation was carried out with the object of obtaining a solution to the problem of a symmetrically loaded circular plate with a central hole, the thickness of the plate at any section being proportional to the distance of the section from the center of the plate. Six particular cases were investigated, and the values of the maximum stress and deflection calculated for various ratios of the external diameter of the plate to the diameter of the central hole. These values were compared with the corresponding values obtained for plates of constant thickness by A. M. Wahl and G. Lobo ["Stresses and Deflection in Flat Circular Plates With Central Holes," Trans. ASME, vol. 52 (1), 1930, p. 29.]

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**The Basic Elastic Theory of Vessel Heads Under Internal Pressure,** by G. Watts, Mem. ASME, and W. R. Burrows, Standard Oil Company (Indiana), Chicago, Ill. 1947 ASME Annual Meeting paper No. 47—A-141 (mimeographed; to be published in the *Journal of Applied Mechanics*).

Means are outlined for calculating internal-pressure stresses and deformations at or near the junctures of semi-infinite cylindrical vessel shells with hemispherical heads, ellipsoidal heads, toriconical heads, torispherical heads, conical heads, and flat heads. The accurate Love analysis isused in this development. A system of dimensionless variables is proposed for each head shape to define the changes in that shape and the changes in the relative thicknesses of the heads and cylinders. Ways are devised to show the critical head stresses in terms of these dimensionless variables either by graphs or by tabulations. The fundamental theory is sufficiently described to indicate how all results are derived.

# Lubrication

**Proposed Recommended Practices for the Preparation of New Turbine Lubricating Systems,** prepared by Technical Committee C, Section 1, ASTM Committee D-2, and sponsored by the Applications Subcommittee of the Process Industries Division. 1947 ASME Annual Meeting paper No. 47—A-39 (in type; to be published in Trans. ASME).

Numerous discussions between the representatives of turbine builders, operators, oil suppliers, turbine-equipment suppliers, and consulting turbine engineers in attendance at meetings of Technical Committee C, Section 1, of the American Society for Testing Materials, have indicated the desirability of pooling the available experience with respect to the preparation of new turbine lubricating systems in order that the most desirable practices might be standardized. The pooled information contained in this paper should be considered a "guide to desirable practices."

It is emphasized that the preparation of new turbine lubricating systems on large or small units in land or marine service be accomplished through the cooperative efforts of the turbine builder, the operator, and the oil supplier.

Under "manufacturers' practices" such items as piping; cast and fabricated parts other than tanks or gear cases; and oil tanks and gear cases are discussed.

Flushing and displacement are discussed with regard to "cleaning after erection—direct-connected units."

Under "geared and marine sets" a procedure embracing the following is presented: cleaning steel pipes, valves, and fittings; protection of steel pipes, valves, and fittings during storage; protection of main reduction gears; cleaning main lubricating-oil sump tank; cleaning and flushing lubricating-oil systems; and circulation of lubricating oil.

While proper construction and preparation of the system are essential, additional factors include adequate facilities for oil maintenance, proper use of such facilities, and means adopted for periodic checking of oil quality.

# Steam Locomotive Design

**Some Important Considerations in the Design of Coal-Burning Steam-Turbine Locomotives,** by John S. Newton, Mem. ASME, Westinghouse Electric Corporation, Philadelphia, Pa. 1947 ASME Annual Meeting paper No. 47—A-148 (mimeographed).

Important considerations in the design of coal-burning steam-turbine locomotives include locomotive capacity, inlet steam pressure and temperature, exhaust pressure, boiler and furnace efficiency, and the means of transmitting power to the rails. Evaluation of the effects of these factors lead to the conclusion that the design of a moderate-capacity coal-burning steam-turbine locomotive should receive further attention. Such desirable features as high tractive effort, coal and water consumption per horsepower hour less than two thirds of modern coal-burning steam locomotives, and a relatively clean stack, appear promising of attainment.

The builders of Diesel-electric locomotives have found that standardization is possible. This is because of the greater uniformity of fuel, the use of very little water, and the electric transmission. It appears that in approaching a degree of standardization which has been found important, a steam locomotive should be provided with an electric transmission, or its equivalent, suitably treated water (already a practice of several railroads), and the ability to burn most coals, but not necessarily all of them.

A reasonably universal steam locomotive having 4000 to 5000 hp available for traction is proposed. The significance of establishing this capacity is that the boiler designer will have the opportunity to make an efficient steam generator within space limitations that may be reasonably allotted. The steam requirements will be reduced to a maximum generation in the range from 45,000 to 55,000 lb per hr instead of the 100,000 or more lb per hr required by large modern passenger and freight reciprocating-engine locomotives.

A set of curves illustrating the effect of steam pressure, steam temperature, and capacity on the steam required by a turbine for 4000-hp, 5000-hp, 6000-hp, 7000-hp locomotive application; the effects of steam pressure and temperature on heat consumption; and the relation between coal-fired and turbine capacity are included.

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# COMMENTS ON PAPERS

*Including Letters From Readers on Miscellaneous Subjects*

## Code Restrictions on Welding

To the Editor:

Welding construction is being handicapped by code writers putting restrictions of no value, but of great expense, on welded structures made under their codes. Part of these handicaps come from the desire of certain manufacturers, equipped with certain unusual facilities, to exclude from competition those who do not have such facilities. Part of it is lack of knowledge on the part of the writers of the codes. Part of it seems to be plain cussedness. The following illustrations will show some of the distortions used to limit welding and to increase its cost.

The method of joining steel plates has been the riveted joint for generations. Results have been satisfactory, yet it is impossible to make a riveted joint as strong as the parent metal. It is, however, impossible in mild steel to make a welded joint of equal sections which is not stronger and will not break the plate in tension. However, the code writers, in spite of these facts, make the following restrictions on welded structures.

If a welded joint is made of equal strength to a riveted joint, the riveted joint is accepted, the welded joint rejected.

If a welded joint is made of equal ductility to a riveted joint, the riveted joint is accepted, the welded joint rejected.

If a welded joint is made with the same undercut from calking, as is normally done in a riveted joint, the riveted joint is accepted, the welded joint rejected.

If a welded joint is made with the same porosity as a riveted joint, the riveted joint is accepted, the welded joint rejected.

If magnaflux or x-ray is used on a welded joint and it shows the same voids as it would on a riveted joint, the welded joint would be rejected, the riveted joint accepted.

If a welded joint is made with the same surface appearance as a riveted joint, the welded joint would be rejected, the riveted joint accepted.

If a welded joint is made with the same fatigue value as a riveted joint, the riveted joint would be accepted, the welded joint rejected.

If a welded joint is made with the same tightness as a riveted joint, the riveted joint would be accepted, the welded joint rejected.

If a welded joint is made with the same tendency toward caustic embitterment as a riveted joint, the welded joint would be rejected, the riveted joint accepted.

There has never been a weld failure in any insured pressure vessel. In spite of this, progressively greater handicaps are placed on welding whose sole purpose is to make welded structures cost more. Already there have been billions of dollars unnecessarily wasted in this way.

Perhaps what we need is a new code for welding code writers rather than for welded constructions. Perhaps we can then deal with reality in this matter.

J. F. Lincoln.[1]

[1] President, The Lincoln Electric Company, Cleveland, Ohio. Mem. ASME.

## Professional Engineering State Laws

To the Editor:

Members of the Society who are interested in practice as consulting engineers may be glad to have data on states that prohibit professional engineering by corporations.

The outstanding example is New York State for engineering corporations organized subsequent to 1935.

Other states with similar provisions in various degree are Rhode Island, Connecticut, Pennsylvania, Ohio, South Dakota, and Idaho.

Some states such as South Carolina have an ambiguous requirement in this regard.

The National Council of State Boards of Engineering Examiners, Post Office Drawer 1404, Columbia, South Carolina, publishes at cost for $2 a digest of the laws of the various states as to professional engineering.

These data were obtained through a lawyer, the National Society of Professional Engineers, and the National Council for State Boards of Engineering Examiners.[2] Gregory M. Dexter.[3]

## Heat Transfer to Molten Metals

*Correction*

To the Editor:

A number of readers have pointed out to the writer that in his paper on "Heat Transfer to Molten Metals,"[4] the limiting values of temperature distribution for $N_{PR} = 0$, shown dotted in Figs. 3 and 4 are in error. On the basis of Equation [14] the limiting temperature distribution for $N_{PR} = 0$ should be parabolic The dotted portions of the curves in Figs 6 and 9 should therefore be somewhat higher than shown. Changes of the order of 5 per cent in the values of $N_{Nu}$ shown in Figs. 7 and 10, for the lower magnitudes of $N_{PR}$ and $N_{RE}$ will result from this error. Persons interested in obtaining the recalculated values of temperature ratios and Nusselt moduli may do so by communicating with the author.

R. C. Martinelli.[5]

[2] The Founder Societies file material of this nature in the Engineering Societies Library where there are available the 1947, 1943, and 1941 editions of the "Digest of State Laws Governing the Practice of Engineering and Land Surveying and of the State Board Procedures."—Editor.

[3] Mem. ASME.

[4] Transactions of the ASME, vol. 69, no. 8, November, 1947, pp. 947–959.

[5] Associate Professor of Mechanical Engineering, University of California, Berkeley, Calif. Jun. ASME.


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DIGESTS of papers presented at ASME meetings are published in this new and informative section. Papers published in Mechanical Engineering are not included. This month's ASME Technical Digest section appears on pp. 354 to 365. Turn now to these pages and keep abreast of all fields of mechanical engineering.

# REVIEWS OF BOOKS

*And Notes on Books Received in the Engineering Societies Library*

## Improving Supervision

IMPROVING SUPERVISION: A Discussion of Human Relations Problems for Supervisors in Industrial and Business Organizations. By Frank and Robert W. Cushman. John Wiley & Sons, Inc., New York, N. Y., 1947. Cloth, $4^7/_8 \times 7^1/_4$ in., 232 pp., $2.50.

REVIEWED BY JOHN R. BANGS[1]

THIS book is written in a plain, easily understood style; it is generous in its recommendations to other authors for supplementary reading, and is readily understandable by the man who has risen from the ranks.

It is recommended as a reference source for general patterns of good foremanship in many of its chapters. But to characterize it as complete would be false. For example it is generous in its use of the phrase "human engineering" which is today being bandied about the country, but nowhere in the text can a definition of this inappropriate term be found.

If the authors were to substitute the term "human relations" they would more nearly attain the goal which it is quite evident they wished to reach when the book was first planned.

In the opinion of this reviewer the authors in writing this book put themselves in the same position as the farmer whom they tell about on page 171 of "Improving Supervision." To quote, "the farmer. . . was visited by a representative of the State Agricultural College. In commenting upon the condition of the crops and the management of the farm, the agricultural agent explained how certain changes might be made in order to increase profits. The agent also offered to send the farmer some pamphlets, giving information on how he could do the things suggested. The old farmer listened patiently and then remarked: 'Listen, young feller, I already know how to run a farm a damned sight better than I am running this one.' What the farmer probably meant was that he had acquired a lot of information *about* farming that he had not yet been able to *apply*."

By the same token the authors have undoubtedly acquired a broad knowledge of the functions of the supervisor but they leave a doubt with the reader as to whether they have had the opportunity to apply some of it.

In the preface they wish the reader to understand that it was written for the purpose of "making available to all supervisors, ideas which they can apply on their jobs, regardless of the nature of the industry or business in which they are employed." But unless the average supervisor doubles in brass for the president and executive staff of the company for which he works he can well eliminate a good 25 per cent of the text of the book as something beyond the realm of his authority. For the subject matter to that degree treats with policy as it should be laid down by top management and not as formulas to guide the supervisor in self-improvement.

The book leaves one with the impression that the foreman is the *most* important individual in industry and not *one of the most* important figures to be considered. On one page alone it brushes aside the functions of the personnel and industrial-relations department as it exists today as an "attempt to bring together under a single head" various phases of specialized management functions. On another page it condemns the average safety engineer as one who mumbles over a slide rule and last year's accident record, while in another chapter it points out the functions of the various methods of testing job applicants in the personnel and employment office and then practically tells the foreman to forget it and use his own methods as recommended in the text.

In another chapter it treats organized and specialized training, unless headed by a specialist under the production manager, as a mistake and waste of time. But in almost the same breath it states that *any* training unless handled by line supervision is futile.

If this is the case, why is it that at this writing many large industrial firms have found that with the training director assigned to the personnel department and co-operating with both the production manager and all line supervision as a function of service, a highly effective and satisfactory job can be and is being done?

[1] Director of Industrial and Personnel Relations, The Budd Company, Philadelphia, Pa. Mem. ASME.

## Air Conditioning

AIR CONDITIONING. By Herbert and Harold Herkimer. Chemical Publishing Co., Inc., Brooklyn, N. Y., 1947. Cloth, $5^1/_2 \times 8^1/_2$ in., 692 pp., 104 figs., $12.

REVIEWED BY W. E. ZIEBER[2]

THIS book is a very compact and meaty volume on air conditioning. It is more useful to the application engineer and system designer than the apparatus designer. A student, without previous training in the so-called fundamentals such as thermodynamics, heat, power, and heat transfer might find it difficult to grasp the theoretical part of this book. This is because so much had to be crowded into such a small space.

The first nine chapters dwell upon the scientific laws and information that apply to air conditioning. This science phase has been well covered and includes the gas laws, physical and chemical properties of matter, change of state, heat transmission in all its applications, elementary thermodynamics, and the fundamentals applying to air and water-vapor mixtures.

The remaining fifteen chapters thoroughly cover the application of heating and cooling equipment, fans, ducts and air flows, methods of estimating heating and cooling loads, types of applications of air conditioning and the automatic controls required, and a very good detailed estimate of the costs of apparatus and its installation. There are many illustrations of apparatus, tables, and solutions of problems

The chapters on gas laws, physical and chemical properties of matter, and change of state illustrate their use in air-conditioning problems very readily.

The heat and heat-transfer problems of air conditioning are shown in the next three chapters. There are numerous

[2] Director of Research, York Corporation, York, Pa. Mem. ASME.



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tables and formulas covering specific heats, heat transmission through building materials, and heat transfer through heating and cooling apparatus.

The chapter on radiant heating is more practical than theoretical. There are some design data presented which should prove useful to those desiring to apply such heating means.

The presentation of elementary thermodynamics is a good theoretical preparation for the air and water-vapor mixtures chapter which shows actual methods of calculating all the different problems encountered in heating, humidifying, evaporation, cooling, and dehumidifying for air conditioning. The flow of air in ducts and means of measuring flow is well covered. The elements of health and comfort cover odor removal, the comfort chart, sound and noise levels in air-conditioning systems, and air cleaning. Air distribution thoroughly covers selection of fans, outlets required, sheet-metal details, and duct sizes for air distribution.

Heating load covers building losses, different types of heating systems, application of unit heaters, methods of calculating heating loads. Cooling load discusses heat gain through solar-radiation effects, glass, infiltration, and the heat added by various appliances, lights, and doors. This chapter is very comprehensive on this subject of estimating cooling load. The subject of spray systems and cooling towers is thoroughly discussed and illustrations are presented.

A general list of temperatures required for drying various types of products in industrial air conditioning is presented.

The chapter describing the refrigeration requirements explains the different types of refrigeration systems and the evaporators and condensers used in such systems.

There is a presentation of unit air conditioners, small and large air-conditioning systems, the use of the by-pass and the methods of calculating by-pass use, list of temperatures and humidities for various industrial applications. The automatic controls used in industrial air-conditioning systems have been well illustrated.

The authors have made a very comprehensive study and detailed breakdown, of the estimated cost of installed air-conditioning systems. This chapter alone would be well worth the cost of the book for those who are required to estimate the installation costs of air-conditioning systems because of the details that are shown.

The authors have included in this book a number of tables and diagrams from various manufacturers' records and from various other sources, such as ASHVE and ASRE papers and journals that are very useful to the air conditioning engineer when thus assembled.

A good appendix is added covering terminology, abbreviations and symbols, conversion equations, and graphical symbols for drawings. These are all recognized standards but are useful when assembled in a book of this type.

# Jet Propulsion Progress

JET PROPULSION PROGRESS. By Leslie E. Neville and Nathaniel F. Silsbee. McGraw-Hill Book Co., Inc., New York, N. Y., 1948. Cloth, 6 × 9 in., 232 pp., illus., $3.50.

REVIEWED BY D. M. SHACKELFORD[3]

USUALLY behind any scientific development there is one man whose name is associated with it, and the story of that development is not written until a sufficient number of years have elapsed for it to push its own way to public recognition. That this is not true in the case of jet propulsion has been apparent for some time but until now the full scope of the field has never been presented—only close-ups of one corner or another of it. In "Jet Propulsion Progress" the authors present for the first time the over-all picture of German, British, and American programs, detailing the chronology of events and presenting a comprehensive picture of parallel lines of work and tie-ins between the different projects.

That the program was a vast and varied one may be judged from the variety of its sources of personnel, from Dr. Durand (called out of retirement at 83 to head up the NACA's project), to William Bollay (called from his research work at Harvard to active duty as an ensign, to later become lieutenant-commander and head of a research group on long-range projects). Credit is given where credit is due, and the contributions of the many men connected with the various parts of the several projects are enumerated. One feels that some further mention might have been made of background work done in Italy, Switzerland, and Sweden, but on the whole, the treatise is so complete that one wonders at the fact that it can be contained in a volume of only 232 pages. Also included are discussions of the theoretical basis for jet propulsion, future prospects, and detailed descriptions of many of the better-known jet engines.

The authors' style is informal and reads easily, giving one the feeling of being taken backstage or of hiding under the table at top-level conferences. Human incidents are interspersed, such as the story of the operator who "was as surprised and gratified as anyone else when it (the jet-propulsion engine) started."

Persons not immediately connected with jet-propulsion work will be interested in the story behind the publicity releases which have appeared from time to time in the technical and popular presses. The value of the book for them is further enhanced by the addition of a glossary of technical terms, as well as a rather extensive bibliography, and a table of the chronology of aircraft gas-turbine developments.

Men already engaged in work in this field will be interested in learning the extent of the program and will feel as though they were watching a jig-saw puzzle as the various pieces, in the form of their colleagues, companies, and already-familiar engines, drop into place within the well-defined framework. For anyone who will be directly or indirectly concerned with apportioning appropriations for research work, it is almost required reading for it sounds a grim warning.

Much has been released heretofore on superior advances made by German research work, nevertheless the second chapter of "Jet Propulsion Progress" entitled "How the Nazis Beat Us to It" really packs a punch. It relates how, except for a disagreement within the German High Command over the most effective use for the Me-262 jet fighter (on which the wrong decision, fortunately for the Allies, was taken) Allied bombers probably would have been swept from the skies over Germany, and how close the Germans were to accomplishing this in spite of mistakes; so close, indeed, that General Spaatz's operational deputy stated to General Eisenhower that if the ground forces didn't take Germany by June, 1945, (this was in February) the German rate of production of jet and rocket planes would make Allied losses in daylight bombing too great to be profitable. The fact that the Allies were able to accomplish this is proof of the effectiveness of the teamwork utilized, but the margin by which it was accomplished was so small that it should give pause for thought. The authors close by saying: "In this and in the related fields of aviation development, history has proved that we can rely completely upon the

[3] Research Engineer, American Locomotive Company, New York, N. Y. Jun. ASME.

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contributions of our scientists and technicians. But the cost in money of research and development in these new fields is rising far above the level of earlier work. . . . . In the softer era of uncertain peace, we are showing signs of indifference while nations nearer bankruptcy than ourselves appear to realize the importance of the work far more than we do. We can maintain our present lead only as long as we accept the burden and support the government-military-industry teamwork that has proved so effective in the past. If this volume can convince its readers of the importance of maintaining the lead, not only for military security but for fuller enjoyment of that security, it will have served its purpose."

## Books Received in Library

AIRPLANE DESIGN. By K. D. Wood. Eighth edition, published by the author, Karl D. Wood at Boulder, Colo., distributed by the University Bookstore, Boulder, Colo., 1947. Stiff paper, $8\frac{1}{2} \times 11$ in., lithoprinted, paged in sections, illus., diagrams, charts, tables, $6. This textbook on airplane layout and preliminary design calculations aims to demonstrate the application of the fundamentals of fluid mechanics, thermodynamics, aerodynamics, strength of materials, and structures to the development of improved airplane types. A practical manual, covering both physical and production aspects, the book emphasizes, as well, trends in design which are substantiated by the technical documents and data released since the war. The present work is complementary to the author's "Technical Aerodynamics."

ALGEMENE METALLURGIE. Deel I (Leerboek der Algemene Metallurgie, Siderurgie, Electrosiderurgie en Metallografie). 248 pp., 270 Bel. frs.

SIDERURGIE en ELECTROSIDERURGIE. Deel II. 454 pp., 430 Bel frs. By Albert De Sy. N. V. Standaard Boekhandel, Antwerpen, Brussel, Ghent, Leuven, 1947. Fabrikoid, $6\frac{1}{4} \times 9\frac{3}{4}$ in., diagrams, charts, tables. Two volumes of a series of three expanded from a manual of instruction for students in the state university in Ghent. Volume I is a text on general metallurgy and covers such topics as metallurgical operations, fuel and its application to metallurgy, metallurgical furnaces, and refractories. Such processes as roasting, smelting, fuming, electric heat-treatment, electrolysis, and sintering are discussed. Volume II treats the particular subject of ferrous metallurgy, and deals with such topics as pig iron, blast furnaces, and steelmaking. Direct and indirect methods of steel production are included, and the Siemens-Martin, Bessemer, Thomas, and Perrin processes are described. A third volume covers metallography.

APPLIED THERMODYNAMICS. By A. C. Walshaw. Blackie & Son, Ltd., London, England, and Glasgow, Scotland, 1947. Cloth, $5\frac{3}{4} \times 8\frac{3}{4}$ in., 401 pp., diagrams, charts, tables, 30 s. Intended as a review text, this volume deals with the principles and general theory of thermodynamics and their application to the steam plant, internal-combustion engines, compressors, and refrigerators. Symbols used are approved by the British Standards Institution. There are a great many worked examples and exercises with solutions.

ASTM STANDARDS ON ELECTRICAL INSULATING MATERIALS (with related information), prepared by ASTM Committee D-9 on Electrical Insulating Materials; Specifications, Methods of Testing; September, 1947. Paper, $6 \times 9$ in., 574 pp., illus., diagrams, tables, charts, $4. (ASTM members, $3). This 1947 compilation presents in their latest form some 90 specifications and tests of interest to engineers, purchasers of electrical insulating materials, and other technologists in the electrical and related industries. An index gives detailed listings of the wide range of materials covered and test methods included, and provides references to certain apparatus and discussions on significance of tests.

LES CATHODES CHAUDES, Théorie et Pratique. By C. Biguenet. Éditions de la Revue d'Optique Théorique et Instrumentale, 165 rue de Sévres, Paris 15e, France, 1947. Paper, $5\frac{1}{2} \times 9$ in., 183 pp., illus., diagrams, charts, tables, 300 frs. Devoted to the practical and theoretical study of hot cathodes, this volume includes a discussion of the basic principles of industrial vacuum technique, the use of induction heaters in releasing gas from metals, the study of adsorption phenomena, the theory of electronic emission, and the study of monoatomic-coated cathodes. The book also deals with other cathode types, particularly the oxide types, and with the formation and use of thoriated tungsten filaments.

CELLULOSE PLASTICS. By D. N. Buttrey. Cleaver-Hume Press, Ltd., London, England, 1947. 127 pp., 7s 6d. FABRIC REINFORCED PLASTICS. By W. J. Brown. Cleaver-Hume Press, Ltd., London, England, 1947. 148 pp., 7s 6d. METALLIZATION OF PLASTICS. By J. R. I. Hepburn. Cleaver-Hume Press, Ltd., London, England, 1947. Cloth, $4\frac{3}{4} \times 7\frac{1}{4}$ in., 71 pp., illus., diagrams, charts, tables, 6s. Of these three volumes covering various aspects of the plastics field, the first one listed discusses the covering of plastic materials with a metallic deposit in order to modify their mechanical, optical, electrical, thermal, or chemical properties. The plastics and metals most suitable for use, the various methods available, and the testing of the resultant deposits are treated. The second volume emphasizes general principles rather than specific commercial applications of cellulose plastics. The occurrence and chemical nature of the raw materials, the nitration of cellulose and processing of nitrocellulose plastics, the manufacture and uses of cellulose acetate, and preparation and applications of the recently developed cellulose esters are presented. In the third volume, the manufacture and uses of fabric-reinforced plastics are dealt with, and special attention is paid to those factors in resin, in fabric, and in manufacture which influence physical properties. All volumes contain bibliographies at ends of chapters.

COMPRESSED AIR HANDBOOK, Applications, Equipment, Engineering Data and Test Procedure. Compressed Air and Gas Institute, New York, N. Y., 1947. Cloth, $6 \times 9$ in., 387 pp., illus., diagrams, charts, tables, $3. This volume is an authoritative guide for the proper installation, use, and maintenance of air compressors and air-actuated equipment. Divided into five parts, the first presents a graphic account of the many common uses of compressed air. The types of machinery used for compressing air are illustrated and described in part two, while part three is devoted to a discussion and illustrations of air-operated devices and mechanisms. Suggestions and data on the selection, installation, operation, and care of the compressed air plant are given in part four. The final section contains engineering data and standards established by the Institute.

CONTROLLED ATMOSPHERES IN HEAT-TREATMENT. By G. T. Dunkley. Sir Isaac Pitman & Sons, London, England; Pitman Publishing Corporation, New York, N. Y., 1947. Cloth, $5\frac{1}{2} \times 8\frac{3}{4}$ in., 69 pp., illus., diagrams, charts, tables, 7s 6d., $1.75. Reviewing current uses, this volume discusses methods of producing controlled atmospheres, and the elementary theory of the gas-metal reactions which occur. This small British volume also describes the types of controlled atmospheres in commercial use with both ferrous and nonferrous metals.

ELEMENTARY ENGINEERING THERMODYNAMICS. By V. W. Young and G. A. Young. Third edition. McGraw-Hill Book Company Inc., New York, N. Y., and London, England, 1947. Cloth, $6 \times 9\frac{1}{4}$ in., 268 pp., diagrams, charts, tables, $3. As in the previous editions, the purpose is to give the engineering student a sound theoretical foundation for the study of heat and power apparatus. This revision embodies the changes in recent years and places greater stress on the application of thermodynamics to practical design. New material has been added on the Brayton cycle and its application in the gas turbine and jet propulsion, and in the introduction of supersaturation of nonequilibrium in steam flow. A chapter on atmospheric air and the psychrometric chart is included as a foundation for the study of air-conditioning processes.

ELEMENTS OF ACOUSTICAL ENGINEERING. By H. F. Olson. Second edition. D. Van Nostrand Company, Toronto, Can., New York, N. Y., and London, England, 1947. Cloth $6 \times 9\frac{1}{4}$ in., 539 pp., diagrams, charts, tables, $7.50. Presenting the principles and applications of acoustics for the engineer and applied scientist, this volume covers the important new instruments, designs, developments, and present-day practices of acoustical engineering. A large number of useful formulas, tables, and graphs are included, together with a consideration of acoustical elements, acoustical radiating systems, mechanical vibrating systems, transducers, architectural acoustics, and the characteristics of speech, music, and hearing. This second edition has been brought up to date and amplified. Two new chapters on underwater sound and supersonics and ultrasonics have been added.

ELEMENTS OF AIRCRAFT PROPELLER DESIGN. By F. T. Meacock. E. & F. N. Spon, Ltd., London, England, 1947. Cloth, $5\frac{1}{4} \times 8\frac{1}{2}$ in., 96 pp., illus., diagrams, charts, 12s, 6d

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This volume discusses propeller design in general terms with a minimum of technicalities and requires only an elementary knowledge of aerodynamics. It is not intended as a manual or handbook on propeller design. Many illustrations supplement the text and the main trends in the development of propeller design are indicated with their underlying reasons.

ELEMENTS OF RAILROAD ENGINEERING. By W. G. Raymond, H. E. Riggs, and W. C. Sadler. Sixth edition. John Wiley & Sons, New York, N. Y., Chapman & Hall, London, England, 1947. Cloth, 5¾ × 9 in., 442 pp., illus., diagrams, charts, tables, $5. The sixth edition of this standard text has been revised and, where necessary, rewritten to include information in line with current practice, particularly with regard to speeds, curves, grades, track structure, division points, and terminal facilities. Two new chapters have been added on streamlined trains and on power and passenger equipment. The four major sections cover the following topics: the railroad industry in general; permanent way; the locomotive and its work; railroad surveys.

ENGINEERING TESTS: CIVIL, MECHANICAL, AND ELECTRICAL. (Arco Civil Service Series.) By A. Liebers. Arco Publishing Company, New York, N. Y., 1947; 49 pp.; Civil Engineering Test Questions, Sample Examinations, 24 pp., diagrams, tables, paper, 8 × 10½ in., $2.50. This volume presents a careful selection of Civil Service engineering tests with answers, for use of those who wish to enter public service. The various types of examination questions are demonstrated, acceptable work methods are indicated, and sample examinations with the time limits are included for self-checking.

ESCALATOR METHOD in Engineering Vibration Problems. By J. Morris with a foreword by G. Temple. John Wiley & Sons, Inc., New York, N. Y., 1947. Cloth, 5½ × 8½ in., 270 pp., diagrams, tables, $4.50. The escalator process, devised for the solution of Lagrangian frequency equations, makes it possible to treat a complicated system in a simple manner by dealing with its constituent parts. The solution of each of these parts is made available with appropriate linking co-ordinates or reactions. The complete system is solved in manageable form by elimination of these linkages, furnishing an effective means for dealing with vibration problems. Many of the author's original contributions to aeronautical engineering are included. The book also deals with other methods of computation of structural stresses, the theory of elasticity, methods of strain energy, and least work.

FLUID MECHANICS OF TURBOMACHINERY. By G. F. Wislicenus. McGraw-Hill Book Company, New York, N. Y., and London, England, 1947. Cloth, 5½ × 8½ in., 613 pp., diagrams, charts, tables, $7.50. This text presents, in organized form and consistent nomenclature, much of the modern development in theory and practice in the field of water, gas and steam turbines, centrifugal and axial flow pumps, compressors, propellers, and hydraulic torque converters and couplings. Its principal subdivisions treat of similarity, general theory of one, two, and three-dimensional flow with and without friction, compressible fluids, and geometry of turbomachinery. Various theories are compared and their limitations as well as their merits are pointed out. There are many references to theoretical and experimental work. It is intended to aid engineers and designers engaged in or responsible for the design and testing of turbomachinery; however, an assortment of examples included at the ends of many of the chapters should make it attractive for advanced or graduate engineering students.

FUNDAMENTAL PRINCIPLES AND APPLICATIONS OF INDUCTION HEATING. By "Heat-Treater." Chapman & Hall, Ltd., London, W.C.2, England, 1947. Cloth 5¼ × 9 in., 147 pp., illus., diagrams., charts, tables, 10s 6d. The development and applications of industrial heating are discussed, as well as principles of induction and coil design and choice of frequency equipment. Applications to surface hardening, internal hardening, tempering, forging, and other processes are considered. There are many pictures, charts, and graphs.

FUNDAMENTALS OF ENGINEERING MECHANICS. By A. Sloane. Prentice-Hall, Inc., New York, N. Y., 1947. Cloth, 6 × 9¼ in., 379 pp., diagrams, tables, $5.65. This volume deals with the usual material on statics and dynamics which is treated in a text on engineering mechanics. In addition, the principle of virtual work, Mohr's circle as applied to moments of inertia and products of inertia, and a brief introduction to the subject of mechanical vibrations have been included. More attention than is usual is given to engineering kinematics. The text is constructed as a guide for the student to stimulate thinking.

GERMAN ENGINEERS' TOOL INDUSTRY. By C. H. Booth and Associates, Brooklyn, N. Y., 1947. Paper, 5½ × 8½ in., 200 pp., illus., diagrams, tables, $10. Prepared by the British Intelligence Objectives Committee, this survey presents individual reports on various types of tools as well as the general report. Appendixes contain tables, diagrams, and pictures of tools and machines. Summaries of the individual "target" reports are given.

ILLUSTRATED JIG-TOOLING DICTIONARY. By T. G. Thompson and R. A. Peterson. The Macmillan Company, New York, N. Y., 1947. Cloth, 6 × 9½ in., 349 pp., illus., diagrams, tables, $5. Containing illustrated factual data alphabetically arranged, this volume graphically demonstrates all of the basic equipment of the tool engineer and the actual use of this equipment on the job. Mathematical procedures, tables and formulas, the properties of metals, standards and basic dimensions, and terms used in connection with plastic-forming processes, welding, technical drawings and blueprints are included.

INDUSTRIAL EXPERIMENTATION. By K. A. Brownlee. Chemical Publishing Company, Brooklyn, N. Y., 1947. Cloth, 5½ × 9 in., 151 pp., diagrams, charts, tables, $3.75. Of primary interest to those concerned with pilot-plant and plant-scale experiments on chemical-manufacturing processes, this volume, British in origin, is a guide to both the planning and interpretation of experiments on an industrial scale and paves the way to efficient quality control. The subject is treated from the practical point of view. Only simple arithmetic is used with the statistical methods discussed and in the practical examples which illustrate the method. The principal additions in this second edition are two new chapters on balanced incomplete blocks and on confounding, covering the problem of restricted block size in factorial experiments.

(AN) INTRODUCTION TO HEAT ENGINES. By E. A. Allcut. University of Toronto Press, Toronto, Ontario, Can., 1946. Cloth, 6 × 9¼ in., paged in sections, illus., diagrams, charts, tables, $3.25. The book provides a concise, interesting introduction to the field of heat engines in which the existence of the same general scientific principles in all types is indicated. Each chapter is illustrated by applications to steam engines, turbines, air compressors, and internal-combustion engines, their similarities as well as differences being pointed out. An excellent historical survey is given. This second edition has a few revisions and some new illustrations.

INTRODUCTORY PHYSICAL METALLURGY. By C. W. Mason. American Society for Metals, Cleveland 3, Ohio, 1947. Cloth, 6 × 9¼ in., 134 pp., illus., diagrams, charts, tables, $3. Composed of lectures given at the 1947 National Metal Congress, this volume discusses the following phases of physical metallurgy: metal crystals; alloys as solid solutions; the working and annealing of metals; the unmixing of solid and liquid solutions; solid solution in brasses and bronzes; transformations and heat-treatments of iron and steel; and corrosion. All discussions are principally in general terms to encourage the student.

MAGNETIC CONTROL OF INDUSTRIAL MOTORS. By G. W. Heumann. John Wiley & Sons, Inc., New York, N. Y., Chapman & Hall, London, England, 1947. Cloth, 6 × 9¼ in., 589 pp., illus., diagrams, charts, tables, $7.50. Of interest to engineers concerned with industrial control equipment, this volume provides exhaustive coverage of electric-motor performance, characteristics of control devices, and functions of commonly-used control circuits. Fundamental information is provided as well as information on new devices such as the amplidyne control and a-c hoist controls. Emphasis is placed on considerations governing the selection of controllers to perform specific jobs. A bibliography follows each chapter.

PLYWOOD, What It Is—What It Does. By L. H. Meyer. McGraw-Hill Book Co., New York, N. Y., and London, England, 1947. Cloth, 6 × 9¼ in., 250 pp., illus., diagrams, tables, $3. Covering effectively the composition, structure, and mechanical characteristics of plywood and kindred laminates, this manual also provides information on the selection and use of plywood. Various types of plywood are discussed with a practical evaluation of their applicability, superiority, limitations, and manufacturing processes. Data on wood species and bonding agents are given.

POWER FACTOR IN YOUR PLANT. By W. C. King. Cornell-Dubilier Electric Corporation, South Plainfield, N. J., 1946. Cloth, 6 × 9¼ in., 214 pp., illus., diagrams, charts, tables, $3. This volume provides the answers to basic questions about power factor and its importance, synchronous motors, and capacitors. It is written simply and directly for those without an engineering background who want to find practical solutions to their electrical problems. Simple arithmetic is all the mathematics needed. A bibliography of current periodical literature and of books is included. Diagrams, charts, and tables are extensively used for more graphic illustration of the various aspects dealt with in the text. Space is devoted to cost comparisons.

TVRDÉ KOVY, obrábeni materiálu, vyvoj tvrdych kovu a jejich pouziti. By Evzen Hirschfeld. Second enlarged edition. Vydalo Nakladatelstvi, Práce v Praze, Prague, Czechoslovakia, 1947. Paper, 5¾ × 8 in., 274 pp., illus., diagrams, charts, tables. Dealing with hard metals for machine tools, this manual covers metal-cutting fundamentals and economic considerations, the production and use of carbides and other hard metals, and effective combinations of tool types and metals to be cut. A historical survey of the hard metals, information on shop layout, and the installation of new tool types are also included.

# ASME BOILER CODE

## Proposed Revisions and Addenda to Boiler Construction Code

IT IS the policy of the Boiler Code Committee to receive and consider as promptly as possible any desired revisions of the rules and its codes. Any suggestions for revisions or modifications that are approved by the Committee will be recommended for addenda to the code, to be included later in the proper place.

The following proposed revisions have been approved for publication as proposed addenda to the Code. They are published herewith with corresponding paragraph number to identify their location in the various sections of the code and are submitted for criticism and approval from anyone interested therein.

It is to be noted that a proposed revision of the Code should not be considered final until formally adopted by the Council of the Society and issued as pink-colored addenda sheets. Added words are printed in SMALL CAPITALS; words to be deleted are enclosed in brackets []. Communications should be addressed to the Secretary of the Boiler Code Committee, 29 West 39th St., New York 18, N. Y., in order that they may be presented to the Committee for consideration.

Pars. P-1 and U-12. Add the following as (**b**):

(b) Carbon steel parts such as pipe fittings valves, flanges, nozzles, welding necks, welding caps, manhole frames and covers, shall be made of materials listed in Section II of the Code or in an accepted standard (such as ASA) covering the particular type of pressure part. Such parts shall be marked with the name or trademark of the manufacturer and such other markings as required by the several standards. Such marking shall be considered as the manufacturer's guarantee that the product complies with the material specifications and standards indicated and is suitable for service at the rating indicated. The intent of this paragraph will have been met if, in lieu of the detailed marking on the part itself, the parts described herein have been marked in any permanent or temporary manner which will serve to identify the part with the manufacturer's written listing of the particular items and such listing is available for examination by the inspector.

Pars. P-102(**a**), (**b**), and U-68(**a**), (**b**): In (**a**) of these paragraphs, second line, place an * after the words "same specifications," and add the following footnote:

"* To be of the same specification, the steel must have a chemical analysis within the specification limits—the same kind, i.e., killed, semikilled, or rimmed, and the same thickness and joint preparation as that used in the shell plate being welded."

In (**b**) of these paragraphs, first section, change "same material" in the second sentence to "specification;" replace the second section (top of page 71 of Code) by the following:

The welding process and the welding operators used in the welding of nozzles shall be qualified under Section IX of the Code.

In Par. U-68(**b**), omit "nozzles" in the first sentence.

Par. P-102(**e**). Revise second section to read:

The tensile strength of the joint specimen in Fig. P-2 when it breaks in the weld shall be not less than the minimum of the specified tensile range of the plate used. (The tension test of the joint specimen as specified herein is intended as a test of the welded joint and not of the plate.) If the specimen breaks in the plate at not less than 95 per cent of the minimum of the specified tensile range of the plate and the weld shows no sign of weakness, the test may be accepted as meeting the requirements. If the specimen breaks in the plate below this strength tolerance because of a local plate defect, one additional specimen shall be tested and shall meet the requirements.

Par. P-186(**d**). Revise first sentence of third section to read:

Fusion-welded construction may be used in lieu of riveted joints in the fireboxes OR FLAT PORTIONS OF WRAPPER SHEETS of internally fired boilers, provided the welds are between two rows of staybolts, or in the case of flat surfaces, the weld is not less than one half of a staybolt pitch from the corner.

Tables P-5 and U-4. For SA-213, add the following stress values:

| Temperature, deg F | Grade T8 | Grade T19 | Grade T18 | Grade T20 |
|---|---|---|---|---|
| 1150 | ... | ... | ... | 5300 |
| 1200 | ... | ... | ... | 4000 |
| 1250 | 2600 | 2600 | 2600 | 3100 |
| 1300 | 1950 | 1950 | 1950 | 2350 |
| 1350 | 1450 | 1450 | 1450 | 1800 |
| 1400 | 1100 | 1100 | 1100 | 1350 |
| 1450 | 800 | 800 | .. | 1050 |
| 1500 | 600 | 600 | .. | 800 |

For SA-249, change the stresses shown at 1150 F from 4250 to 4500, and at 1200 F from 3050 to 3400. Add the following stress values:

| Temperature, deg F | Grade T8 | Grade T19 | Grade T18 | Grades T20 and T24 |
|---|---|---|---|---|
| 1250 | 2200 | 2200 | 2200 | 2650 |
| 1300 | 1650 | 1650 | 1650 | 2000 |
| 1350 | 1250 | 1250 | 1250 | 1550 |
| 1400 | 950 | 950 | 950 | 1150 |
| 1450 | 700 | 700 | .. | 900 |
| 1500 | 500 | 500 | .. | 700 |

For SA-158, add the following stress values

| Temperature | −20 to 650 | 700 | 750 | 800 | 850 | 900 |
|---|---|---|---|---|---|---|
| Grade P5b | 12000 | 12000 | 12000 | 11800 | 11000 | 8800 |
| Grade P15 | 12000 | 12000 | 12000 | 11500 | 11000 | 10000 |
| Temperature | 950 | 1000 | 1050 | 1100 | 1150 | 1200 |
| Grade P5b | 6000 | 4200 | 3000 | 2000 | 1400 | 900 |
| Grade P15 | 8000 | 5000 | .. | .. | .. | .. |

Heating Boiler Code, Preamble. Revise first sentence of second paragraph to read:

For the purposes of these rules, a domestic water heater is one which supplies hot water and is connected to a tank with a CUBICAL capacity of 120 gal or less.

Specification of SA-285. Replace references to SA-70 and SA-89 by a reference to SA-285 in the following paragraphs:
P-2, P-15, P-103(**a**), P-186(**a**), A-66 (**a**), A-67, A-68, Table P-7; U-13, U-71, U-80, U-91, U-120, UA-13(**a**), UA-14, UA-15, Table U-2; L-2, L-3, L-11, L-12, L-27, L-29, L-103; H-6, H-74; M-2, M-4(**b**).

Par. P-5. Omit references to Specifications SA-30 and SA-70.

Par. U-110. Revise to read:

The plate for any part of a vessel to be welded by electric-resistance butt welding shall be of [a-quality] WELDABLE QUALITY in accordance with Par. U-71 [Specification SA-89].

Specifications A 299, A 300, A 301, A 302. Include references to A 299, A 301 and A 302 in Pars. P-2, P-103, Tables P-5 and P-7.

Include references to A 299 and A 301 in Par. U-13(**c**) (1) revised, with the addition of the statement: "and for all thicknesses of SA-302;" include reference to A 299 and A 301 in Par. U-13(**c**)(2) revised. Include references to A 299, A 301, and A 302 in Pars. U-71 and U-120.

Par. U-59(**b**). Revise first sentence of last section to read:

Piping connected to the [flanges of] outlets [nozzles] on a pressure vessel, etc.

Add the following as item (5):

(5) By welding to nozzles or fittings if the rules for fusion welding or forge welding are followed.*

* When the contents of the vessel are noxious or inflammable, or the piping so attached is subject to clogging due to products of cor-



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rosion, special consideration should be given to the need for effective drainage, cleaning, and venting.

Fig. U-1. Revise as follows:

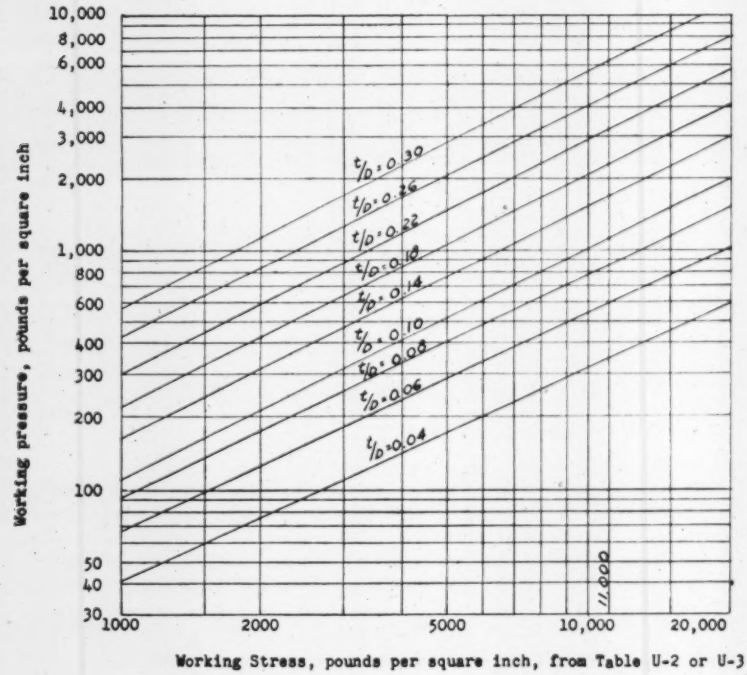


FIG. U-1 CHART FOR DETERMINING WALL THICKNESS OF TUBES UNDER EXTERNAL PRESSURE

(Temperature differential between inside and outside shall be considered in establishing the thickness.)

Par. U-68(c). Revise first sentence to read:

When there are several pressure parts being welded in succession on any one order, the plate thicknesses of which fall within a range of 1/4 in., with diameters differing not more than 6 in., and of the same grade of material, a test plate shall be furnished for each 200 ft, or fraction thereof, of the main welded joints.

Pars. U-140 to U-142. Revise to read:

U-140 *Materials.* (a) Materials shall conform to the specifications given in Par. U-13 and in addition the requirements of this paragraph and of Pars. U-141 and U-142. If the vessels are fabricated by fusion welding, the materials, if ferrous, shall conform to the specifications given in Par. U-71;[1] and if nonferrous with Specifications SB-96 or SB-98 for copper-silicon alloys,[1] SB-127 for nickel-copper alloy, SB-111 for cupronickel alloy, SB-11, SB-13, SB-42, SB-75, SB-111 for copper,[1] SB-126 for aluminum-manganese alloy, or SB-178 for aluminum. In the absence of adequate specifications for other physical forms of nonferrous materials authorized above, such other forms are acceptable provided the chemical composition and corresponding physical requirements of an approved specification are met.

(b) (To be retained as it appears in Code.)

(c) All materials shall meet the impact test requirements of Par. U-142 unless exempted therein. For certification by the manufacturer of the materials as provided in that paragraph all ferrous materials shall be given an appropriate normalizing heat-treatment and all nonferrous materials shall be given an annealing heat-treatment. If welded, the deposited weld metal and the heat-affected zone shall also meet the impact test requirements of Par. U-142.

U-141 *Design.* Except as provided in this paragraph the design and construction of vessels to operate at temperatures of —20 F and below shall conform to the other rules of this Code that are applicable to the type of fabrication used. If of welded construction they shall conform to the requirements given in Pars. U-68, U-69, or U-200 to U-210, inclusive, and when special materials authorized by Cases are used see [footnote referring to Par. U-140(a)] to the requirements of the appropriate Case. All ferrous vessels except austenitic stainless steel vessels shall be stress relieved. Austenitic stainless steel vessels shall be given one of the heat-treatments provided in Case No. 897. Nonferrous vessels except as exempted by the Cases authorizing their use shall be stress relieved at an appropriate temperature. All finished vessels including welds shall be free of notches, grooves and abrupt changes of section that act to concentrate stresses.

(a) Materials that have been impact tested and meet the requirements of Par. U-142(f), and materials that have not been impact tested because exempted under Pars. U-142(a)(1), U-142 (a)(3) or U-142(a)(4) may be used at the maximum working pressure, at stresses not to exceed the maximum allowable design stresses permitted in Table U-2 for ferrous materials for temperatures of —20 F to 650 F for any riveted, Par. U-68 or Par. U-69 vessel and at not to exceed 125 per cent of these values for any Par. U-200 or Par. U-201 vessel; or if nonferrous at not to exceed the maximum allowable design stresses permitted in Table U-3 for nonferrous materials for temperatures of subzero to 150 F for any riveted, Par. U-68 (when otherwise authorized) or Par. U-69 vessel.

(b) Material that has not been impact tested because exempted under Par. U-142(a)(2) may be used at the maximum working pressure at stresses not to exceed those allowed in (a) for riveted, Par. U-68 or Par. U-69 vessels.

(c) [Retain existing (b) covering special seamless containers without change except to renumber as (c)].

U-142 *Impact Tests.* (a) Material. Except as provided in (1), (2), (3), (4) below, all material for shell, heads, nozzles, or other pressure parts in each vessel shall be given an impact test at the lowest temperature to which the vessel may be subjected during its operating cycle:

(1) No impact test is required on any material for use at temperature above —20 F or for temporary use below that temperature when caused by a temporarily lower ambient atmospheric temperature.

(2) No impact test is required when the operating cycle is such that the pressure at —20 F is less than one fifth of the maximum allowable working pressure for which the vessel is designed.

(3) No impact test is required on material made to any specification listed below provided the lowest temperature of operation is not below the minimum temperature listed for that particular specification: (Material as normally produced to meet these specifications is believed to be dependably ductile above the minimum listed.)

| Specification number | Minimum temperature for use without impact test |
|---|---|
| SA-240 Grades S, M, C, or T | —300 F |
| Grade Mc | See Case No. 897 |
| SB-11 if deoxidized | —300 F |
| SB-96 or SB-98 | —150 F |
| SB-127 | —200 F |

[Editorial Note: Suggested list of specifications and minimum temperatures subject to approval, addition, and correction by different material groups.]

(4) No impact test is required on material of less than 0.098 in. thickness or for reinforcing material around openings that do not require reinforcement in accordance with Par. U-59.

(b) *Welded Vessels.* (1) If the vessels are of welded construction, test plates similar to those required by Par. U-68 shall be prepared for each vessel except as provided in

[1] For welding of copper-silicon alloys see Case No. 864, for nickel-copper see Case No. 935, for copper see Case No. 934, for aluminum-manganese see Case No. 994, for austenitic stainless steel see Case No. 897.

(2). The test plate material shall be taken from one of the heats of material used in the vessel, and both the weld rod and the process of welding shall be the same as used in fabrication of the vessel. One set of impact specimens shall be taken across the weld with the notch in the weld metal and one set shall be similarly taken with the notch in the adjacent metal in the heat-affected zone.

(2) For small vessels not exceeding the volume limitations defined by items (1) and (2) of Par. U-1(a), one set of impact specimens of the material may represent all vessels from the same heat of material not in excess of 100 vessels or one heat-treatment furnace batch, whichever is smaller. In addition, when such vessels are welded, one test plate made from one of the heats of material used and two sets of impact specimens cut therefrom may represent the weld metal and the heat-affected zone metal, respectively, of one lot of 100 vessels or less, or of each heat-treatment furnace batch, whichever is smaller.

(c) *Number of Tests—Location.* (1) Each set of impact tests shall consist of three specimens.

(2) Certified reports of impact tests by the material producer will be acceptable evidence provided the specimens taken are representative of the material delivered and that the material is not subjected to treatment during or following fabrication that will reduce its impact properties. If such treatment is subsequently applied to the material, impact specimens shall be so taken and treated as to be representative of the material in the finished vessel.

(3) For material that is not of sufficient thickness to permit the preparation of full size specimens, tests may be made on the largest of the subsize specimens listed in section (f) below. On material of thickness greater than $^1/_2$ in., the specimens shall be taken from a location as near as practicable to a point midway between the surface and the center of thickness. The base of the notch shall be perpendicular (normal) to the surface.

The requirements for certification on various types of material are as follows.

(4) *Plate Material.* The producer of ferrous plates may certify such material provided it has been given an appropriate normalizing heat-treatment, by reporting the results of tests of one set of impact specimens taken from each plate as rolled.* The length of the impact specimen shall, whenever possible, be taken parallel to the direction of the expected maximum stress. When the direction of maximum stress is unknown the producer may certify on the basis of specimens taken parallel to the final direction of rolling. In particulars not specified in Pars. U-140 to U-142, inclusive, Specification SA-300 shall govern.

The producer of nonferrous plates may certify such material provided it has been given an annealing heat-treatment and sampled in accordance with the requirements for certification of ferrous plates.

*Note: The term "plate as rolled" used herein refers to the unit plate from a slab or rolled directly from an ingot in its relation to the location and number of specimens; not to its condition. If the plate is sheared or otherwise cut into smaller sizes after rolling, the impact test made from the original plate shall govern the parts thereof.

(5) *Pipe or Tube Material.* The manufacturer of ferrous pipe or tube material may certify such material by reporting the results of tests of one set of impact specimens provided the following requirements for production and sampling are met. One set of specimens may represent all of the pipe or tubes produced from one heat of steel poured from a single melting furnace charge and subsequently processed in the same manner provided all are given a normalizing heat-treatment in a continuous treating furnace in which the temperature is automatically controlled and checked by recording pyrometer. One set of specimens may represent all of the pipe, tubes, or welding fittings produced from the same, that have been given a normalizing heat-treatment as a single charge in a batch treating furnace equipped with recording pyrometers provided all have been produced from a single melting furnace heat and subsequently processed in the same manner. If more than one melting furnace heat is present in the batch heat-treating furnace some means of identification shall be provided and one set of specimens taken from each heat.

One set of impact specimens shall be taken from one pipe or tube picked at random from each heat or furnace batch or portion thereof to be certified. The specimens shall have the major axis parallel to the length of pipe or tube. In the case of welding fittings the specimens may be taken from the tubing prior to forming provided the fittings are normalized after forming. Such specimens shall be normalized before testing.

The manufacturer of nonferrous pipe or tubes may certify such material under the same requirements as for ferrous pipe or tubes except that an annealing heat-treatment shall be used.

(6) *Forgings or Rolled-Steel Flanges. Forged Fittings.* The manufacturer of forgings for any purpose may certify them by reporting the results of tests of one set of impact specimens taken from each melting furnace heat of material provided the following requirements for production and sampling are met. Upon receipt of each heat of material, a test block shall be taken from a section of at least one billet or bloom selected at random. Each test block shall be subjected to a similar reduction and heat-treatment as the finished forging, being reduced by forging in an amount approximately the same as received by the forgings to be represented by such block. One such test block shall represent all forgings from the same heat, the maximum thicknesses of which do not exceed by more than 125 per cent, but not more than $1^1/_2$ in., the thickness of the section from which the test specimens are taken. One set of impact tests shall be made from each test block. The major axis of these specimens shall be parallel to the length of the block. The results thus obtained shall be considered as representative of all items forged, within the thickness limitations given above, from the heat sampled without additional test bars being made provided the heat-treatment of the finished forgings is within the temperature limits prescribed for the test block heat-treatment and is done in automatically controlled furnaces equipped with recording pyrometers. In the absence of such facilities, one set of specimens shall be required from each heat represented in each heat-treatment charge.

(7) *Bars, Rolled, or Forged.* The manufacturer of forged or rolled bars may certify such bars by reporting the results of one set of impact specimens from each bar or from each lot of bars produced from a single melting furnace heat, processed in a similar manner, and heat-treated as a single furnace batch, if heat-treated.

(8) *Castings.* The manufacturer of castings may certify them by reporting the results of one set of impact specimens taken from each melting furnace heat, these specimens being taken either directly from a production casting or from test coupons cast attached thereto providing the following additional requirements are met. Any set of specimens shall represent only such castings from the same heat, the minimum thicknesses of which are not less than 75 per cent of, or the maximum thicknesses of which do not exceed by more than 125 per cent, but not more than $1^1/_2$ in. the thickness of the section from which the test specimens were taken. A wider range of thicknesses from one heat may be covered by taking additional sets of specimens from thicker or thinner material as may be required. The results thus obtained for a range of thicknesses shall be considered as representative of all items within that range of thicknesses cast from the heat sampled without additional test bars being made provided the heat-treatment of test specimens and all castings represented is the same and is done in automatically controlled furnaces equipped with recording thermometers. In the absence of such facilities, however, one set of impact specimens shall be required for each heat represented in each heat-treatment charge in each range of thickness involved.

(9) *Small Parts.* The manufacturer of small parts either cast or forged may certify a lot of not more than 20 duplicate parts by reporting the results of one set of impact specimens taken from one such part selected at random provided the same kind of material and the same process of production was used for all of the lot. When the part is too small to provide the three specimens of at least minimum size shown in Fig. U-32, no impact test need be made.

(10) *Special Seamless Vessels.* The manufacturer of the special seamless vessels provided for in Pars. U-140(b) and U-141(c) shall take one set of impact specimens from each vessel from the end before the shell is thickened for closure except as provided in Par. U-142(b) (2).

(d) *Temperature of Tests.* Impact test specimens shall be tested at the lowest temperature to which the vessel may be subjected in its operating cycle. The specimens shall be uniformly cooled by subjecting them to the test temperature for at least 30 minutes. The handling tongs shall be cooled similarly. The test shall be made within 8 seconds after removal from the cooling medium.

(e) *Test and Test Specimens.* The impact

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test specimens shall be of the Charpy type, keyhole or milled U notch, and shall conform in all respects to Fig. U-32. The standard 10 mm × 10 mm specimen shall be used where the thickness is $^{7}/_{16}$ in. or greater and, for thinner material, a similar specimen shall be used except that the dimension along the axis of the notch shall be reduced to the largest possible of 7.5 mm, 5 mm, or 2.5 mm.

(f) *Impact Test Requirements.* The impact properties of each set of impact specimens shall be not less than the values in the following table:

| Size of specimen | Minimum impact value required for avg of each set of three specimens, ft-lb | Minimum impact value permitted on one specimen only of a set, ft-lb |
|---|---|---|
| 10 mm × 10 mm | 15 | 10 |
| 10 mm × 7.5 mm | 12.5 | 8.5 |
| 10 mm × 5 mm | 10 | 7.0 |
| 10 mm × 2.5 mm | 5 | 3.5 |

When the average value of the three specimens equals or exceeds the minimum value permitted for a single specimen and the value for more than one specimen is below the required average value or the value for one specimen is below the minimum value permitted for a single specimen, a retest of three additional specimens shall be made, each of which retest specimen must equal or exceed the required average value.

When an erratic result is caused by a defective specimen, or there is uncertainty in test procedure, a retest will also be allowed.

(g) *Heat-Treatment of Test Plates.* The test plates shall be given the same heat-treatment as the material they represent. When normalized ferrous material is being tested the test bars shall be normalized preferably before removal from the material sampled but if done separately shall be heat-treated within the temperature range specified by the producer in treating the material from which the bars were taken. Nonferrous test bars shall be annealed within the temperature range used for annealing the material represented.

(h) *Stamping.* The stamping required by Par. U-66 shall be modified as follows when a vessel is intended for use at −20 F or below except for temporary use under the conditions stated in Par. U-142(a)(1). The minimum temperature for which the vessel is suitable as well as the maximum shall be stamped on the vessel or the attached plate as "allowable temperature range" by obliterating "max" from the third line and adding the word "range" after "temperature" in the caption underneath. Further there shall be added following the figures for the minimum temperature the initials "I.T." if the material has been impact tested at the minimum temperature. These initials shall not be added when the low temperature of operation without impact testing results from application of exemption permission of Par. U-142(a).

Par. U-201(d). Revise second section of revision appearing in the March issue to read:

The hammer test as specified in Par. U-77(b) shall be made under a hydrostatic pressure of not less than $1^{1}/_{4}$ times but not more than 1.6 times the maximum allowable working pressure, except that vessels 36 in. or less in diameter may be tested to 2 times the maximum allowable working pressure.

Par. UA-19(a). At the end of the sentence add ". . Tables U-2 and U-3."

Par. UA-19(b). Revise to read as follows:

(b) Nuts shall be semifinished, chamfered, and trimmed to at least American Standard heavy dimensions as given in Table UA-7. The use of washers is optional but when used they shall be of wrought material. Nuts and washers for ferrous bolts and studs shall be made in accordance with Specification SA-194. Nuts and washers for nonferrous bolts and studs shall conform to an approved plate or sheet specification for washers and an approved rod or bar specification for nuts.

Par. UA-19(e). Substitute the word "steel" for "such" in the second line to make the first sentence read:

Flanges that are to be fusion welded shall be of good weldable quality and the carbon content of steel material shall not exceed 0.35 per cent.

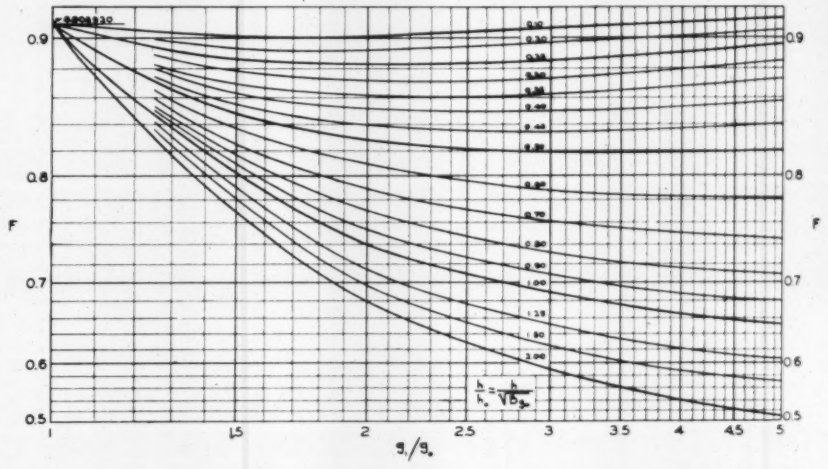
Par. UA-19(f). Change to read as follows:

(f) Flanges shall be made of forged, rolled, cast or plate material in accordance with the specifications in Section II of the Code for which allowable working stresses are given in Tables U-2 and U-3, except that hubbed flanges shall not be machine cut from plate material. Flanges shall not be made from material conforming to Specification SA-181 when the flange thickness exceeds 3 in. or the flanges conform to ASA dimensions for primary service pressure ratings of 400 lb or higher. Flanges may be fusion welded only when the material is listed as permissible for welding in Par. U-71(a).

Par. UA-20(c). Delete Note 1 following this paragraph. Subsequent notes to be renumbered.

Table UA-9. At the end of the definitions for $S_b$, $S_a$, $S_f$, add: ". . Tables U-2 and U-3."

Fig. UA-6. Replace present charts in Code for $F$ and $V$ with revised charts attached.



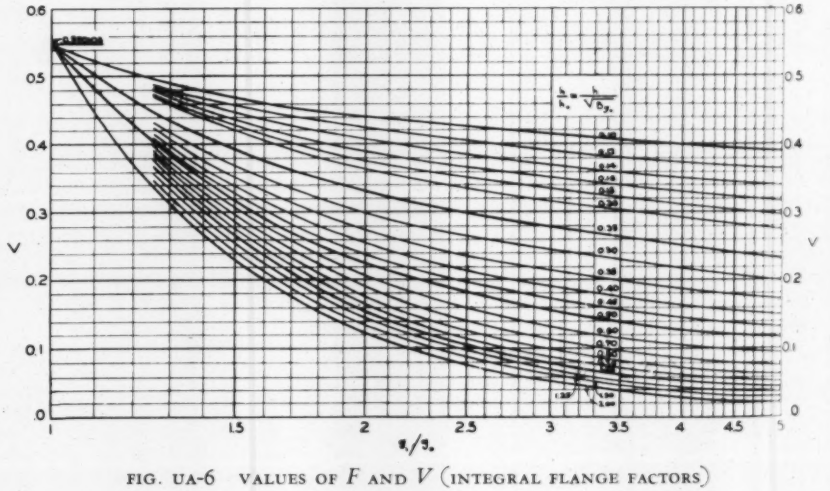




FIG. UA-6 VALUES OF $F$ AND $V$ (INTEGRAL FLANGE FACTORS)

Table U-3. Revise the stresses for SB-171, aluminum bronze,* to read: From subzero to 150 F—18,000 psi; 250 F—16,000 psi; 300 F—14,500 psi; 350 F—13,500 psi; 400 F—12,500 psi; 450 F—11,000 psi; 500 F—10,000 psi.

* This material is approved for tube sheet use only.

# ASME NEWS

*And Notes on Other Engineering Societies*

COMPILED AND EDITED BY A. F. BOCHENEK

BIRD'S-EYE VIEW OF THE BUSINESS DISTRICT OF MILWAUKEE, WIS., SCENE OF ASME 1948 SEMI-ANNUAL MEETING

## ASME 1948 Semi-Annual Meeting to Feature Industrial Products and Facilities of Wisconsin

### *Headquarters: Schroeder Hotel, Milwaukee, Wis. May 31–June 5, 1948*

INDUSTRIAL products of Wisconsin as well as the unsurpassed industrial facilities of Milwaukee will be on display during the ASME 1948 Semi-Annual Meeting to be held at the Schroeder Hotel, Milwaukee, Wis., May 31–June 5, 1948.

In addition to the regular technical program and a full schedule of social events and inspection trips, the ASME Milwaukee Section is sponsoring the "Industrial Wisconsin Engineering Exposition" to demonstrate the importance and diversification of Wisconsin's industry.

The ASME Milwaukee Section extends a most cordial invitation to members and friends of the ASME to plan to be in Milwaukee during the first week of June. Members are especially urged to bring their wives. Special entertainment and inspection trips are being arranged for the women by the Milwaukee Section of the Woman's Auxiliary to the ASME.

Milwaukee is the nation's tenth largest industrial city. It was originally called Mahn-auau-kie, meaning "good lands" and later as Melwarek, Milwaky, and finally Milwaukee. Located on Lake Michigan, 85 miles north of Chicago, Milwaukee is famous for its parks, zoo, music events, "old world" restaurants, and charming houses. Hospitality and an interest in entertainment is characteristic of its 630,000 people. Not only does Milwaukee lead the world in the production of Diesel and gasoline engines, outboard motors, and motorcycles, but it is also the largest veal-packing center, the greatest barley market, and the location of four of the seven largest breweries in America. It also leads the nation in the production of silk hosiery, work shoes, leather gloves and mittens, tin and enamelware, sawmill and flour-mill equipment.

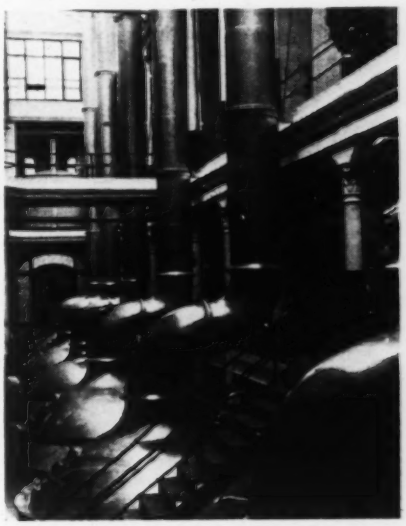
#### Technical Program

Thirty-one technical sessions have been planned for the five-day meeting by the following Professional Divisions and Committees: Applied Mechanics, Aviation, Cutting Fluids, Education, Fuels, Gas Turbine Power, Heat Transfer, Hydraulics, Industrial Instruments and Regulators, Machine Design, Management, Materials Handling, Metal Cutting Data and Bibliography, Metals Engineering, Nuclear Energy, Oil and Gas Power, Petroleum, Plastic Flow of Metals, Power, Production Engineering, and Railroad. Sessions are also planned by the American Rocket Society.

A tentative program of technical sessions will be published in the May issue of MECHANICAL ENGINEERING.

#### Many Inspection Trips Planned

Inspection trips have been scheduled to five of Milwaukee's principal industries where members will see, among other things, the largest Diesel engine ever built, the largest welded-pipe plant in the world, the largest wind-tunnel fan ever constructed, and the Port Washington Power Plant of the Wisconsin Electric Power Company, "the world's most efficient power plant." Of special interest will be the visit to the plant of the Kearney and Trecker Corporation which is celebrating its 50th anniversary in the machine-tool industry. Among other Milwaukee plants to be visited are Nordberg Manufacturing Company; Falk Corporation; A. O. Smith Corporation; Allis-Chalmers Manufacturing Company.



COPPER CAULDRONS WHICH ARE LOCATED IN THE PABST BREW HOUSE ALONG THE VISITORS' ROUTE THROUGH PABST CITY



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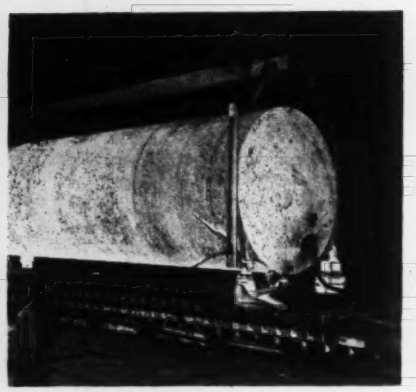

GLASS-LINED BEER STORAGE TANK EMERGING FROM FURNACE AT THE A. O. SMITH CORPORATION PLANT, MILWAUKEE, WIS.

Among the social events that will high-light the program will be a dinner on Friday, June 4, sponsored by the University of Wisconsin and the ASME Milwaukee Section. Speakers will include Alex D. Bailey, past-president and Fellow, ASME, Governor Oscar Rennebohm of Wisconsin, Edwin B. Fred, president, University of Wisconsin, and Dean Morton O. Withy of the University of Wisconsin. The main speaker will be Julius Krug, Secretary of the Interior.

### Committee

The following members are in charge of local arrangements for the Semi-Annual Meeting: Theodore Eserkaln, honorary chairman; Theodore Wetzel, general chairman; George Sirotkin, secretary; George Miniberger, financial chairman; Ernest Szekely, chairman, Reception Committee; Donald Naulin, chairman, Exhibits Committee; Alfred Schmidt, chairman, Program Committee; Alfred Hoppe, chairman, Inspection Trip Committee; Eric Laabs, Women's Program Committee; J. Verne Resek, chairman, Banquet Committee; Robert Miller, chairman, Entertainment Committee; A. Warren Colwell, chairman, Publicity Committee; and George Suchy, chairman, Service Committee.

## New Research Society Organized

THE Scientific Research Society of America, a new national scientific organization designed primarily for industry, has been established with headquarters at Yale University, New Haven, Conn.

This new body is sponsored by and affiliated with, The Society of the Sigma Xi, a national honorary scientific organization in American universities, which also has its headquarters at Yale University. As a nonprofit corporation devoted to the encouragement and promotion of scientific research the SRSA will organize local chapters in industrial laboratories and sponsor national lectureships, publications, and grants in aid, to develop an exchange of ideas about the latest trends in scientific research, and offer other aid not now available to research workers.

## James C. Peebles to Retire

JAMES C. PEEBLES, member ASME, dean of engineering at Illinois Institute of Technology, Chicago, Ill., will retire at the end of August after an association with Illinois Tech and its predecessor institutions which extends over nearly a half century.

Dean Peebles will be succeeded by John T. Rettaliata, member ASME, director of the department of mechanical engineering at the Institute. At 36, Dr. Rettaliata will be one of the youngest deans of engineering in the United States. He has been active in ASME affairs since his student days at Johns Hopkins University, Baltimore, Md. Dr. Rettaliata received the ASME Junior Award in 1941 and the Pi Tau Sigma Medal in 1942. Currently he is serving as the chairman of the ASME Gas Turbine Power Division.

ASME 1948 SEMI-ANNUAL MEETING GENERAL COMMITTEE OF CHAIRMEN

(*Seated, left to right:* George Sirotkin, secretary; George Miniberger, finance; Ernest Szekely, reception; Theodore Wetzel, general chairman; Alfred Hoppe, inspection trips; A. Warren Colwell, publicity. *Standing, left to right:* J. Verne Resek, banquet; George Suchy, service; F. Warren Weithofer, Section secretary; Donald Naulin, exhibits; Theodore Eserkaln, honorary chairman; Eric Laabs, women's program; and not shown, Alfred Schmidt, program; and Robert Miller, entertainment.)

## ASME National Nominations

THE 1948 Nominating Committee invites members to appear at its open meeting May 31, 1948, at the Schroeder Hotel, Milwaukee, Wis. Members may present their views concerning candidates for the office of President, Regional Vice-President, or Director at Large any time between the hours of 10 a.m. to 12 noon; and 2 p.m. to 4 p.m.

## ASME National Parks Tour Planned

A TWO-WEEK National Parks Tour is being planned for members and friends of the ASME who expect to attend the ASME 1948 Fall Meeting to be held at Reed College, Portland, Ore., Sept. 7 to 9, 1948.

According to plans, the tour will leave New York, N. Y., on August 29, 1948, continue leisurely across the continent stopping for sight-seeing visits at the Yellowstone, Teton, and Mount Rainier National Parks, and will arrive in Portland in time for the technical and social events of the Fall Meeting. On the return trip a four-day sight-seeing stop will be made at the Glacier National Park, after which the group will continue on to New York, arriving on Sept. 14.

The tour will be under the personal supervision of Ernest Hartford, assistant secretary ASME, and will be limited to members and friends of the ASME. Similar tours have been enjoyed by hundreds of members in the past and have been popular because of the advantages inherent in an ASME sponsored tour as compared to the normal "commercial" tour.

Prices for the tour from New York, N. Y., will range from $450 to $500. This includes hotel rooms and meals (except during the Fall Meeting), sight-seeing tours, transportation to and from railroad stations and hotels, handling luggage, and taxis. At the various hotels and park inns arrangements are being made for the best accommodations and meals.

Members interested in the tour are invited to write the office of the Secretary of the Society, 29 West 39th Street, New York 18, N. Y., for further information. In order to know how many accommodations to provide on trains and the various hotels, Headquarters needs some idea of the number who expect to participate. Members who feel that there is a possibility of making the tour are invited to make tentative reservations. These reservations may be canceled at will.

# Engineering Societies Yearbook Published by ASME Lists 318 Engineering Bodies

THE Engineering Societies Yearbook, 1948," published in early March by The American Society of Mechanical Engineers, under the sponsorship of The Engineers Joint Council, describes eight international engineering organizations, 275 U. S. and 35 Canadian societies.

This is the first of what is planned to be a periodical series of this reference source on the purposes, activities, membership, policies, and new developments of all engineering societies, clubs, and councils.

Engineering joint bodies, national, regional, state, and local organizations are included. There are also sections on student branches of national societies, on engineering employee organizations, State Registration Boards, and on accredited engineering colleges and curricula.

This information has been classified and indexed to assist governing bodies and secretaries of all the societies. The sponsors also hope that this Yearbook will aid the officers, committee chairman, local-sections officers, student branches, and staff members of each society, by facilitating liaison on matters of common concern. In each case this involves contacts with other engineering societies, colleges, publishers, libraries, research groups, trade associations, industries, and government agencies.

Special questionnaires to secure the data for the Yearbook were mailed in the fall of 1947, and the replies were received between September and December.

A typical entry gives the name, abbreviation of name (if any), year organized, address, facilities, type of organization (council, or society, or combination), purposes, joint activities, number of members of each grade, fees and dues, where members live, yearly budget, names and addresses of president and secretary (with dates terms of office expire), committees, technical divisions, meetings, publications (with subscription price and whether or not accepting advertising), scholarships or loan funds, awards, and important new developments of the past year.

For each national society information is also included on its various local sections, student branches, and other component divisions.

The eight international organizations described include: International Committee on Scientific Management, International Union of Theoretical and Applied Mechanics, International Congress on Applied Mechanics, International Electrotechnical Commission, International Organization for Standardization, UNESCO, World Engineering Conference, and World Power Conference.

The Foreword points out that if the accumulated need by 1950 for new engineers in the United States, as estimated by the Bureau of Labor Statistics, is met by the graduation of 90,000 students between 1946–1950, this will mean that in 1950 about 46 per cent of all engineers will have entered the profession within the 10-year period 1940–1950. The absorption of such a large percentage of neophytes into the profession poses a great challenge to the professional-engineering organizations of the country in preserving high standards of professional performance, of technical-committee work, of publications, of professional guidance, and of public service.

The five societies sponsoring the Yearbook (ASCE, AIME, ASME, AIEE, and AIChE) report a total of 119,588 members in the fall of 1947, of whom 22,517 are student members. It is estimated that there will be approximately 337,000 members of the profession by 1950.

The price of the Yearbook is $3. Copies are available from ASME Publication-Sales Department, 29 West 39th St., New York 18, N. Y.

## Air Forces Honor W. F. Durand

FOR supplying "the leadership necessary for successful research in jet engines for aircraft" Dr. William F. Durand, past-president and honorary member ASME, emeritus professor of engineering at Stanford University, recently received the Presidential Medal for Merit. It was pinned on him at Moffett Field by Gen. Carl Spaatz, chief of staff of the Air Force. The citation pointed out that Dr. Durand started his work in World War II at the age of 81 and that he served without pay.

## MECHANICAL ENGINEERING Cited as "Good Reading"

MECHANICAL ENGINEERING was cited as "good reading" by the Committee on College Reading of The National Council of Teachers of English in a book "Good Reading—A Guide to the World's Best Books," published by the Penguin Books, Inc.

MECHANICAL ENGINEERING was the only publication of a national professional-engineering agency to be included in a list of magazines of special interest recommended by the Committee of English teachers. Other publications mentioned were *Business Week*, *Survey Graphic*, *School and Society*.

In the chapter on "How to Use Good Reading" which mentions MECHANICAL ENGINEERING, other magazines listed under classifications other than "special interest" were *The Atlantic Monthly*, *The Nation*, and *The Saturday Review of Literature*.

Wm. J. Ellenberger, member ASME, who found the Committee's commendation of MECHANICAL ENGINEERING, wrote in a letter to the staff, "I feel that the membership should be apprised of the selection of our magazine as representative of the technical journals published in the United States."

## April ASME News High Lights

ASME Sections in Milwaukee, Chicago, and St. Louis are putting out the welcome mat for members who plan to attend ASME summer meetings.

Industrial Wisconsin will be on display during the ASME Semi-Annual Meeting May 31–June 5 (375–376). In Chicago during the three-day Conference on Applied Mechanics, June 17–19, members will visit the editorial offices of *Applied Mechanics Reviews* (382). Fifty years of the Diesel engine in America will be marked by the Oil and Gas Power Division, May 20–22, in St. Louis. Preconference lecture course on lubrication is also planned (381).

According to a statement approved by the Executive Committee defining traditional ASME nominating procedure, "the office shall seek the man rather than have the man or his friends seek the office" (378).

The ECPD Canons of Ethics, has been adopted by the ASME and will be incorporated in the ASME By-Laws (379).

Death of Conrad Matchoss in 1942 was confirmed by a letter received from his daughter (378).

A free course in practical statistical methods is being offered as a service to industry by the Hunter Pressed Steel Company (382).

Headquarters is planning a National Parks Tour in connection with the ASME Fall Meeting to be held at Reed College, Portland, Ore. (376).

The Engineering Societies Yearbook, 1948, containing descriptions of 318 engineering societies and joint bodies, was published in March by the ASME under sponsorship of EJC (377).

See pages 41 to 64 of advertising section for catalogs and bulletins of latest engineering equipment, materials, and services.

English teachers gave MECHANICAL ENGINEERING a "pat on the back" by citing it as an example of "good reading" (377).

The Scientific Research Society of America, whose object is the promotion of research, was recently established with headquarters at Yale University (376).

John T. Rettaliata was appointed to succeed J. C. Peebles as dean of engineering at the Illinois Institute of Technology (376).

Financial support of individual ASME members will be sought by the Thomas Alva Edison Foundation, Inc. for its 10-year program honoring Mr. Edison (382).

Only one third of ASME members who served in the Armed Services during the war were used in effective engineering capacities, according to returns from a recent questionnaire (380).



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# How the ASME Selects Its Officers

THE following statement, prepared with the assistance of several recent chairmen of the ASME Regular Nominating Committee, was approved recently by the Executive Committee of the Council for publication in MECHANICAL ENGINEERING:

"The Office shall seek the man, rather than have the man or his friends seek the office." This policy, tacitly accepted rather than stated in Society law, is the reason why only one name appears on the ballot for each office to be filled. The presentation of a single name is occasionally questioned as evidence of undemocratic procedure so this statement of how the Society selects its prospective officers has been prepared with the assistance of several recent Nominating Committee Chairmen and its publication authorized by the Executive Committee of the Council.

The procedure of selection may be described as "representative." The members in the seventy-one Sections throughout the country elect their officers, who in turn select the Regular Nominating Committee and cooperate with that committee to bring forward names of desirable candidates. It is important that this be understood because there seems to be an impression that the Council or some "inner group" selects the Nominating Committee.

The steps of nomination and election are as follows:

### Selection of Regular Nominating Committee

1 In April and May of 1948, the representatives of the Sections at eight Regional Administrative Committee Meetings select the regional representatives and alternates for the Regular Nominating Committee.

2 At the Semi-Annual Meeting business session, this year in Milwaukee on May 31, the members in attendance will vote on the names selected by the regional conferences for the Regular Nominating Committee which will select the candidates to be voted on in the fall of 1949.

### Selecting the Candidates

1 At the Milwaukee Semi-Annual Meeting, the Regular Nominating Committee elected at that meeting, meets and selects its own committee officers and initiates requests to the members and Section officers for the suggestion of suitable candidates.

2 At the 1948 Annual Meeting in New York, the Regular Nominating Committee holds a preliminary meeting to review its progress and take proper subsequent steps.

3 In the January issue of MECHANICAL ENGINEERING the Committee states the qualifications desired in prospective officers and requests proposals of qualified men from the members.

4 The Committee requires the preparation of a formal proposal of a candidate's name by the proposer to insure that the proposer himself is aware of the qualifications of his selection and is not making a casual proposal.

5 If the term of office of the Vice-President of a Region expires during 1949, the Regional representative on the Regular Nominating Committee will preside over the meeting of the Regional Administrative Committee held in the spring of 1949 at which a decision is reached on the candidate or candidates for Vice-President for that Region. This permits the member of the Regular Nominating Committee to present full information regarding the candidate and the wishes of the membership he represents to the Regular Nominating Committee. While it is not mandatory, the general effect is that the Regular Nominating Committee will follow the recommendations of the Regions as to vice-presidential nominees.

6 At the 1949 Semi-Annual Meeting, the Regular Nominating Committee meets and holds open sessions at which members are expected to present and discuss candidates. The slate is selected from many names considered. The list of nominees is required to be made public within two weeks of the meeting, but usually it is completed for announcement at the Meeting.

### Special Nominating Committee

1 A special nominating committee may be organized by one per cent of the members after the announcement of the names presented by the Regular Nominating Committee. This has occurred only once since the present procedure was put into effect in 1920.

### The Letter Ballot

1 The names of nominees are submitted by letter ballot to the membership on or before the third Thursday in August. The ballots are canvassed in New York on the fourth Tuesday of September.

The Rules of the Society permit the inclusion of names of more than one candidate for all offices except the presidency. Despite this provision, which has been discussed each year by the Regular Nominating Committee, the feeling of the committee has usually been that the procedure followed by the Committee as outlined above safeguards the interest of the members and brings forward the names of well-qualified candidates. Election to office in the Society is an honor and as such should not be sought by campaigning in a competitive manner. The selection of able and sincere Nominating Committee members by elected representatives insures able and deserving officers.

## ASME Calendar

*of Coming Events*

**May 20–22, 1948**
ASME Oil and Gas Power Division Meeting
St. Louis, Mo.

**May 31–June 5, 1948**
ASME Semi-Annual Meeting
Milwaukee, Wis.

**June 17–19, 1948**
ASME Applied Mechanics Division Meeting
Chicago, Ill.

**Sept. 7–9, 1948**
ASME Fall Meeting
Portland, Ore.

**Sept. 13–17, 1948**
ASME Instruments and Regulators Division Meeting
Philadelphia, Pa.

**Sept. 20–21, 1948**
ASME Aviation Division Meeting
Dayton, Ohio

**Oct. 3–6, 1948**
Petroleum Committee of the ASME Process Industries Division Meeting
Amarillo, Texas

**Nov. 3–4, 1948**
ASME Fuels Division
White Sulphur Springs. W. Va.

**Nov. 28–Dec. 3, 1948**
ASME Annual Meeting
New York, N. Y.

**Jan. 10–14, 1949**
Materials Handling Division and Management Division Meeting
Philadelphia, Pa.

# Conrad Matchoss Died Writing History of Technology

CONRAD MATCHOSS, former member ASME, and well known to members of the ASME as the secretary of the Association of German Engineers (Verein deutscher Ingenieure) died March 21, 1942, in Germany while working on a universal history of technology, according to his daughter, Lotte Matchoss. While the fact of his death was known to the Society in 1943 and noted in MECHANICAL ENGINEERING, American friends have been concerned over the circumstances of his last days. An anti-Nazi who had strong faith in the engineering profession as an agency for world peace, Dr. Matchoss was deprived of his post early in the Nazi rise to power.

Mrs. Matchoss, who assumed her father's name after the death of her husband, studied at the Iowa State College, Ames, Iowa, in 1927-1928, and will be remembered by American engineers as the young girl who accompanied her father on his visits to this country.

Uncertain whether her father's death was known to his American friends and having lost all of his possessions including addresses in bombings late in the war, Mrs. Matchoss wrote first to a college friend. This correspondence was called to the attention of the ASME.

Mrs. Matchoss is now living with her eight-year-old son under difficult conditions at Aufkirchen, b, Starinberg, Obarbayern, Germany.

Known in Germany for her translation of a book by J. R. Randall on "Our Changing Civilization," Mrs. Matchoss was continually threatened by the Nazis with the loss of her son because, they said, she was not able to educate him "in the right way."

# ECPD Canons of Ethics for Engineers Approved by ASME

THE following code of ethics for engineers was drafted by the Committee on Principles of Engineering Ethics of the Engineers' Council for Professional Development and has been approved by the Council of The American Society of Mechanical Engineers. The ASME Constitution and By-Laws Committee has recommended adoption of the statement as part of the ASME By-Laws. The ECPD Canons of Ethics for Engineers follows:

### Foreword

Honesty, justice, and courtesy form a moral philosophy which, associated with mutual interest, constitute the foundation of ethics. The engineer should recognize such a standard, not in passive observance, but as a set of dynamic principles guiding his conduct and way of life. It is his duty to practice his profession according to these Canons of Ethics.

As the keystone of professional conduct is integrity, the engineer will discharge his duties with fidelity to the public, his employers and clients, and with fairness and impartiality to all. It is his duty to interest himself in public welfare, and to be ready to apply his special knowledge for the benefit of mankind. He should uphold the honor and dignity of his profession and avoid association with any enterprise of questionable character. In his dealings with fellow engineers he should be fair and tolerant.

### Professional Life

Section 1 The engineer will co-operate in extending the effectiveness of the engineering profession by interchanging information and experience with other engineers and students and by contributing to the work of engineering societies, schools, and the scientific and engineering press.

Section 2 He will not advertise his work or merit in a self-laudatory manner, and he will avoid all conduct or practice likely to discredit or do injury to the dignity and honor of his profession.

### Relations With the Public

Section 3 The engineer will endeavor to extend public knowledge of engineering and will discourage the spreading of untrue, unfair, and exaggerated statements regarding engineering.

Section 4 He will have due regard for the safety of life and health of public and employees who may be affected by the work for which he is responsible.

Section 5 He will express an opinion only when it is founded on adequate knowledge and honest conviction while he is serving as a witness before a court, commission, or other tribunal.

Section 6 He will not issue ex parte statements, criticisms, or arguments on matters connected with public policy which are inspired or paid for by private interests, unless he indicates on whose behalf he is making the statement.

Section 7 He will refrain from expressing publicly an opinion on an engineering subject unless he is informed as to the facts relating thereto.

### Relations With Clients and Employers

Section 8 The engineer will act in professional matters for each client or employer as a faithful agent or trustee.

Section 9 He will act with fairness and justice between his client or employer and the contractor when dealing with contracts.

Section 10 He will make his status clear to his client or employer before undertaking an engagement if he may be called upon to decide on the use of inventions, apparatus, or any other thing in which he may have a financial interest.

Section 11 He will guard against conditions that are dangerous or threatening to life, limb, or property on work for which he is responsible, or if he is not responsible, will promptly call such conditions to the attention of those who are responsible.

Section 12 He will present clearly the consequences to be expected from deviations proposed if his engineering judgment is overruled by nontechnical authority in cases where he is responsible for the technical adequacy of engineering work.

Section 13 He will engage, or advise his client or employer to engage, and he will co-operate with, other experts and specialists whenever the client's or employer's interests are best served by such service.

Section 14 He will disclose no information concerning the business affairs or technical processes of clients or employers without their consent.

Section 15 He will not accept compensation, financial or otherwise, from more than one interested party for the same service, or for services pertaining to the same work, without the consent of all interested parties.

Section 16 He will not accept commissions or allowances, directly or indirectly, from contractors or other parties dealing with his client or employer in connection with work for which he is responsible.

Section 17 He will not be financially interested in the bids as or of a contractor on competitive work for which he is employed as an engineer unless he has the consent of his client or employer.

Section 18 He will promptly disclose to his client or employer any interest in a business which may compete with or affect the business of his client or employer. He will not allow an interest in any business to affect his decision regarding engineering work for which he is employed or which he may be called upon to perform.

### Relations With Engineers

Section 19 The engineer will endeavor to protect the engineering profession collectively and individually from misrepresentation and misunderstanding.

Section 20 He will take care that credit for engineering work is given to those to whom credit is properly due.

Section 21 He will uphold the principle of appropriate and adequate compensation for those engaged in engineering work, including those in subordinate capacities, as being in the public interest and maintaining the standards of the profession.

Section 22 He will endeavor to provide opportunity for the professional development and advancement of engineers in his employ.

Section 23 He will not directly or indirectly injure the professional reputation, prospects, or practice of another engineer. However, if he considers that an engineer is guility of unethical, illegal, or unfair practice, he will present the information to the proper authority for action.

## Headquarters News Notes

THE Petroleum Committee of the Process Industries Division has petitioned the Professional Divisions Committee for a change to professional-division status.

The ASME will have complete control of all technical programs for the Materials Handling Exhibit planned by Clapp and Poliak, Inc., in Philadelphia, Pa., January, 1949. Events will be sponsored by the Management and Materials Handling Divisions.

Philip T. Sprague was named honorary vice-president of the ASME to represent the Society at the 90th anniversary of the founding of Iowa State College, Ames, Iowa, March 22, 1948.

Because of wide interest in the formation of a central agency within the Society to deal with lubrication problems, a committee representing the Special Research Committee on Lubrication, Textile Division, Oil and Gas Power Division, Production Engineering Division, Machine Design Division, Petroleum Committee of the Process Industries Division, and Railroad Division is preparing a petition for the organization of a Lubrication Co-Ordinating Committee.

The number of nonmembers serving on ASME Technical Committees is a challenge to all members of the Society. President Bailey will soon send a letter to all chairmen of the technical committees, asking co-operation in securing membership from nonmembers on these committees.

The Junior Committee is studying the method of selecting junior members for service on national committees as junior advisers.

A new constitution has been drafted to improve the machinery of the Engineers Joint Council.



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Section 24 He will exercise due restraint in criticizing another engineer's work in public, recognizing the fact that the engineering societies and the engineering press provide the proper forum for technical criticism.

Section 25 He will not try to supplant another engineer in a particular employment after becoming aware that definite steps have been taken toward the other's employment.

Section 26 He will not compete with another engineer on the basis of charges for work by underbidding, through reducing his normal fees after having been informed of the charges named by the other.

Section 27 He will not use the advantages of a salaried position to compete unfairly with another engineer.

Section 28 He will not become associated in responsibility for work with engineers who do not conform to ethical practices.

# Survey Reveals War Use of Engineering Profession

IN THE summer of 1947 a "Wartime Services Form" was mailed to all ASCE and ASME members in the United States, at the Government's request, calling for data on their engineering and other activities in the Armed Services or in private work during World War II.

These data from 13,349 questionnaires returned in the survey are now being studied by the Committee on Technologic Personnel in Relation to National Security of the Engineers Joint Council headed by Col. James L. Walsh, member ASME. The object of the study is to enable the Committee to aid National Defense Authorities in developing plans for future emergencies to insure the best possible use of the talents of engineers.

The answers reveal conclusively that the best utilization of these engineers' technical and professional training and experience was not made in either their military or civilian wartime service.

The conclusion is clearly indicated that adequate steps should be taken now, in peacetime, both by government agencies and by engineering bodies, to develop better methods of using engineers' abilities in both military and civilian activities in the event of future hostilities.

The degree of utilization while in military service for ASCE and ASME members, and the weighted total, are tabulated in Table I on a percentage basis.

Table I shows that about one third (1) might be called "satisfactory," one sixth (2) "fair," one fourth (3) "passable" one eighth (4) "unsatisfactory," and one eighth (5) "very unsatisfactory" utilization while in military service.

The degree of utilization while in civilian wartime employment, for the members of each Society, and the weighted total, are given in Table II: which shows that about three fourths (1) might be called "satisfactory," one ninth (2) "fair," one twelfth (3) "passable," one fortieth (4) "unsatisfactory," and one thirtieth (5) "very unsatisfactory" utilization while in civilian wartime employment.

It is evident from the two tables that relatively more attention is needed to improve utilization of engineers in military service than in civilian wartime employment.

Utilization in the Armed Forces was also graded according to the method of entry. Of the 1763 in the two Societies who considered themselves in Group (1) ("satisfactory"), 41.6 per cent were secured by direct commission from civilian status; 32.4 per cent from Reserve or National Guard; 21.2 per cent from voluntary enlistment; and only 4.8 per cent by draft.

The War Department is at present engaged in a thorough study of the implications of the survey, which also includes data on other aspects of this question.

TABLE I UTILIZATION WHILE IN MILITARY SERVICE, WORLD WAR II

| Utilization Group | ASCE, per cent | ASME, per cent | Total, per cent |
|---|---|---|---|
| 1 You were utilized in your primary field and at your level of competence (training and experience) throughout most of your military service | 33.7 | 34.4 | 33.9 |
| 2 Utilized as in (1) for at least half of the time you were in military service | 17.4 | 14.1 | 16.2 |
| 3 Not utilized in your primary field of training and experience, but you did utilize throughout your service, the collateral fields in which you had received training or gained experience | 21.8 | 25.9 | 23.4 |
| 4 Utilized in your primary or collateral fields for only a relatively short period | 14.4 | 11.8 | 13.4 |
| 5 Utilized in neither your primary nor in any of your collateral fields | 12.7 | 13.8 | 13.1 |

TABLE II UTILIZATION WHILE IN CIVILIAN WARTIME EMPLOYMENT, WORLD WAR II

| Utilization Group | ASCE, per cent | ASME, per cent | Total, per cent |
|---|---|---|---|
| 1 Utilized in your primary field and at your level of competence (training and experience) throughout most of your employment | 71.1 | 79.3 | 74.9 |
| 2 Utilized in your primary field and at your level of competence for at least half of your employment | 11.3 | 11.0 | 11.2 |
| 3 Not utilized in your primary field of training and experience but you did utilize the collateral fields in which you had received scientific training or gained experience | 9.9 | 6.2 | 8.2 |
| 4 Utilized in your primary or in collateral fields for only a relatively short period of your employment | 3.5 | 1.8 | 2.7 |
| Utilized in neither your primary nor in any of your collateral fields in your employment | 4.2 | 1.7 | 3.0 |

## Meetings of Other Societies

**April 13–15**
Society of Automotive Engineers, Inc., national aeronautic and air transport meeting, Hotel New Yorker, New York, N. Y.

**April 13–16**
Greater New York Safety Council, Inc., 18th Annual Safety Convention and Exposition, Hotel Pennsylvania, New York, N. Y.

**April 18–23**
American Chemical Society, 113th national meeting, various hotels, Chicago, Ill.

**April 25–30**
The American Ceramic Society, Inc., 50th annual meeting, Palmer House, Chicago, Ill.

**April 26–28**
American Mining Congress, coal convention, Netherland Plaza Hotel, Cincinnati, Ohio.

**May 18–21**
National District Heating Association, 39th annual meeting, Hotel Statler, St. Louis, Mo.

**May 27–29**
Society for Experimental Stress Analysis, annual meeting, The Roosevelt Hotel, Pittsburgh, Pa.

**May 30–June 2**
The American Society of Refrigerating Engineers, spring meeting Ocean House, Swampscott, Mass.

**June 1–5**
The Engineering Institute of Canada, annual general and professional meeting, Banff Springs Hotel, Banff, Alberta, Can.

**June 6–11**
Society of Automotive Engineers, Inc., semi-annual meeting, French Lick Springs Hotel, French Lick, Ind.

**June 14–18**
American Society for Engineering Education, annual convention, Austin, Tex.

# ASME 20th National Oil and Gas Power Conference to Mark Half Century of Diesel in America

A COMPREHENSIVE program celebrating the half century of the Diesel engine in America has been planned for the 20th National Oil and Gas Power Conference of The American Society of Mechanical Engineers to be held at the New Jefferson Hotel, St. Louis, Mo., May 20–22, 1948.

Prominent American and foreign Diesel engineers and power experts are scheduled to review outstanding features of Diesel engineering and application. In addition, there are planned inspection trips of prominent manufacturing establishments in and around St. Louis, as well as an entertaining women's program.

Registration, planned for 9:30 a.m. on Thursday, May 20, will be followed at 10:30 a.m. by a technical session at which papers on firing-order studies and computation of torsional-vibration systems will be presented. At the afternoon technical session, engineering progress of the Diesel engine will be probed by experts drawn from both the large- and small-engine fields.

At technical sessions on Friday morning, Diesel applications of an industrial and marine nature will be discussed. For the afternoon inspection trips have been arranged to the plants of Busch-Sulzer Brothers, Diesel Division of Nordberg Manufacturing Company, St. Louis Shipbuilding and Steel Company, Fulton Iron Works, McDonald Aircraft Corporation, Shell Petroleum's Research Laboratories, Aluminum Company of America, and others.

At technical sessions on Saturday morning, rail application of the Diesel engine and centrifugal blowers for Diesel engines will be reviewed.

### Social Events Planned

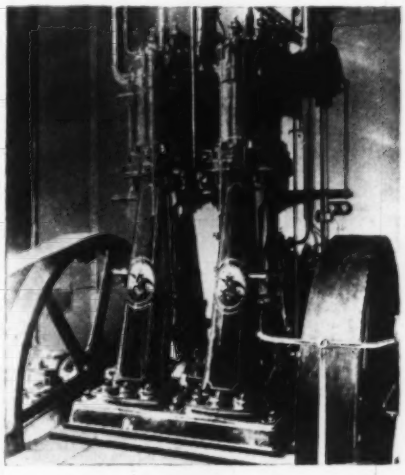
On the social side, a luncheon on opening day will feature Mayor A. P. Kaufmann of St. Louis. The annual banquet, informal as usual and open to the women, will be held on Friday evening, preceded by an exhibitors' social hour. Glenn C. Boyer, chairman, ASME Oil and Gas Power Division, will preside; toastmaster will be Gordon Le Febre, president of Cooper-Bessemer Corporation, and president of Diesel Engine Manufacturers Association; Joseph Holland, prominent St. Louis banker, will deliver the main address.

### Exhibits

As in the past, there is to be an exhibit of the products manufactured by leading builders of the Diesel and related industries. The numerous advance reservations for booth space indicate that this feature of the Annual Conference will be more imposing and informative than ever before.

### Preconference Lectures

Continuing an engineering service feature first instituted at the 19th Conference, where the subject of "Diesel Fuel Oils" was presented, the Oil and Gas Power Division is arranging a special series of lectures dealing with the ever-important subject, "Lubrication." This series, to be held at New Jefferson Hotel on May 19, will be presented at three 2-hour lectures by two recognized experts of national reputation. Mayo D. Hersey, research associate, Massachusetts Institute of Technology, will discuss "Basic Principles of Lubrication" and "Engineering Applications of Lubrication;" and Dr. James B. Rather, Jr., technical service department, Socony-Vacuum Laboratories, "Manufacture, Classification, and Test Significance of Lubricating Oils."



FIRST DIESEL ENGINE TO BE PLACED IN COMMERCIAL SERVICE IN THE UNITED STATES

Registration, which will be restricted to approximately 100 engineers, should be made by mail to the Special Lectures Chairman, John C. Gibb, Room 1348, 26 Broadway, New York 4, N. Y. Fee for the complete series, payable in advance on application, is $12 to ASME members and $15 to nonmembers (checks should be payable to The American Society of Mechanical Engineers, Oil and Gas Power Division, Custodian Fund). Those interested are advised to make application without delay.

As a convenience to those attending the lectures, a special luncheon is planned for 12:15 p.m. between the morning and afternoon lectures.

## The Tentative Program

The Conference technical sessions are tentatively as follows:

**Thursday, May 20**

**10:30 a.m.**

Improved Techniques in Firing Order Studies With the Vectorscope, by George Dashofsky, Brooklyn Navy Yard, Brooklyn, N. Y.

An Improved Method for Computing Torsional Vibration Systems, by Dr. A. W. Hussman.

**2:00 p.m.**

Early Developments of the Diesel Engine, by C. E. Beck, Nordberg Manufacturing Company.

Present-Day Diesel Engines, by Ralph L. Boyer, Cooper-Bessemer (for large engines).

Present-Day Diesel Engines, by Mr. Bennett, International Harvester Company (for small engines).

**8:00 p.m.**

Diesel Engineering Developments During the Last Half Century, by C. G. A. Rosen, director of research, Caterpillar Tractor Company.

**Friday, May 21**

**9:00 a.m.**

Diesels in Industry, by W. T. Watt, vice-president, *Industry and Power*.

Diesels in Inland Waterways Operations, by A. R. Parsons, St. Louis Shipbuilding and Steel Company, and Donald T. Wright, editor, *Waterways Journal*.

Diesels on Salt Water, by Walter L. Green, American Bureau of Shipping.

**1:30 p.m.**

Inspection Trips

**Saturday, May 22**

**9:30 a.m.**

Centrifugal Blowers for Diesel Engines, by Robert Cramer, Jr., Nordberg Manufacturing Company.

Diesels on the Rails, by John Morris, Santa Fe Railroad.

# A. J. Langhammer Receives Powder-Metallurgy Award

ANTHONY J. LANGHAMMER, member ASME, and president of the Amplex Division of the Chrysler Corporation, Detroit, Mich., was the fourth recipient of a medal awarded annually by Stevens Institute of Technology for achievement in the field of powder metallurgy. The presentation was made by H. N. Davis, president of the Institute, Feb. 17, 1948. Following the brief ceremony, Mr. Langhammer delivered the annual medal lecture on "The Industrial Application of the Powder-Metallurgy Process."

Mr. Langhammer described the use of powder metallurgy in the manufacture of many "trouble jobs" and told how application of the process contributed to effective production and foolproof performance of parts subjected to difficult surface conditions. His lecture was devoted chiefly to the use of the process in the manufacture of oil-cushion heavy-duty bearings and machine parts.

The medal presented to Mr. Langhammer was made by the Stevens Powder Metallurgy Laboratory of silver powder pressed and sintered on the campus.



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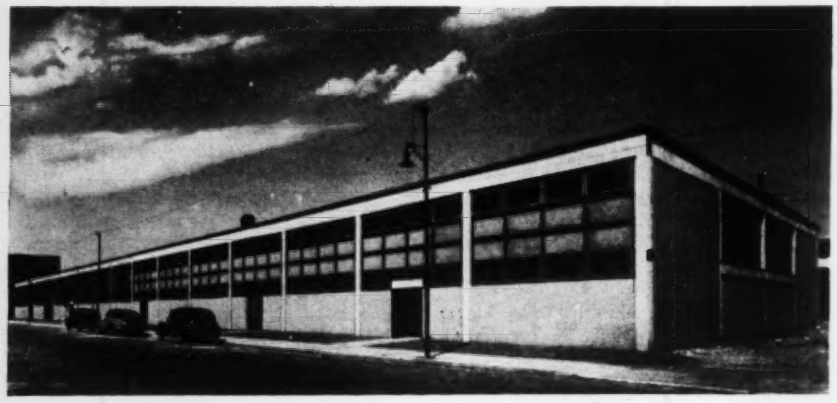

ENGINEERING BUILDING, ARMOUR RESEARCH FOUNDATION, CHICAGO, ILL., WHICH WILL BE VISITED BY MEMBERS ATTENDING THE 14TH ANNUAL CONFERENCE ON APPLIED MECHANICS, JUNE 17–19, 1948

## 14th Applied Mechanics Conference Planned for June 17–19

THE 14th Annual Conference on Applied Mechanics sponsored by The American Society of Mechanical Engineers in cooperation with the ASME Chicago Section, Armour Research Foundation, and Illinois Institute of Technology, will be held at the Technology Center, Illinois Institute of Technology, June 17–19, 1948. A feature of the conference will be a Symposium on Flow and Fracture of Metals.

In addition to six technical sessions to be held in the auditorium of the Chemical Engineering and Metallurgy Building of the Institute, the program will include an inspection tour of the Technology Center. Of special interest will be a visit to the editorial offices of the *Applied Mechanics Reviews* which have been established at the Technology Center.

The technical sessions will discuss such subjects as the law of work hardening, large deformations of an elastic solid, stability of plates reinforced by ribs, the decay of isotropic turbulence, recent studies in plastic flow of metals, and others.

The Local Committee in charge of the Conference is planning special arrangements for rooms and restaurant facilities on the campus. Arrangements with downtown Chicago hotels are also pending.

A tentative program of the Conference will be published in the May issue of MECHANICAL ENGINEERING.

## Wear Conferences Planned at MIT in June

A SERIES of conferences on mechanical wear, to be sponsored by the Massachusetts Institute of Technology, the ASME, and others, will be held in Cambridge, Mass., June 14–16, 1948.

The conferences will discuss causes, symptoms, and cures for wear between solid surfaces. Invited papers will be presented by specialists from industry and universities.

## Edison Foundation to Solicit Support of Engineers

THE ASME and 14 other national engineering societies are supporting a project of the Thomas Alva Edison Foundation, Inc., to raise more than two and a half million dollars to carry out the Foundation's ten-year program which includes: (1) Preservation of the Edison Laboratories and Library; (2) re-establishment of the Edison Scholastic Competitions; and (3) creation of the Edison Center for Invention, Discovery, and Research.

Sponsors of the Foundation, which was established in 1947 by leaders in science, education, and industry, seek to enlist the support of American engineers. ASME members will soon receive a letter from the Foundation soliciting individual contributions to augment the fund of a million dollars already contributed by American industry.

First on the Foundation's program is the purchase and preservation of the laboratory and library buildings at West Orange, N. J., where for 44 years Edison did much of his most important work. The Library was opened to the public on Feb. 11, 1947, on the 101st anniversary of the inventor's birth and now serves as an inspiration to American youth interested in science and engineering.

To encourage the American spirit of competition and to discover high-school students who have a well-rounded interest in science, the Foundation seeks to re-establish the annual nation-wide Edison Scholastic Competitions awarding a four-year scholarship in science. The competitions were discontinued in 1931 following the death of Mr. Edison.

The Edison Center for Invention, Discovery, and Research, also to be established at West Orange, N. J., will support studies in the history and methods of industrial research. To determine the techniques used by Edison, the Center will study the 2500 notebooks which Edison kept while working on his inventions.

Other investigations planned by the Center will seek to establish the relations of mass markets, mass production, and equitable distribution to industrial research in the modern industrial state.

The program of the Foundation will keep alive the spirit of Mr. Edison through its services to science, education, and industry. As Charles F. Kettering, Fellow ASME, and president of the Edison Foundation, said recently, "Every citizen is as much a beneficiary of Mr. Edison as if he had mentioned him in his will."

### "Catalog Briefs"

In this issue beginning on page 41 through to page 64 of the advertising section, are listed 179 items about the latest available catalogs, bulletins, and literature covering engineering equipment, materials, supplies, and services. Use the coupon on page 43 to make a selection.

## Free Course in Statistical Methods Offered

A TWO-DAY free course on practical statistical methods will be given each week beginning April 6, 1948, by the Hunter Pressed Steel Company, Lansdale, Pa., as a service to industry.

The course is intended for inspectors, purchasing agents, product designers, and management men close to the production and purchasing function. It includes seven lectures by top specialists in the field, one forum-type discussion, a complete plant tour to demonstrate Hunter's methods and "taking its own medicine," and a full afternoon of actual testing and calculating practice in using the principles learned. The course will be given in Lansdale, and the only expenses involved will be living and traveling costs.

Engineers who are involved in purchasing and inspection functions are invited to correspond with the Hunter Pressed Steel Company regarding particulars of the course and the possible assignment of men to take it. Ten men can be enrolled at a time and it is suggested that all men from a given company come in a group. Exclusive courses will be arranged for companies of sufficient size so that eight men or more can be trained.

Representative topics to be covered will embrace: the use of the frequency-distribution curve and the correlation chart in inspection for analysis of production troubles; production control charts; outgoing sampling techniques; quality reports; types of defects; causes and detection; sampling; 100 per cent testing; load-testing of springs; pressureless measurement of flexible parts; gaging; supplier reports; lot-to-lot variation; non-normal distribution; spring specifications and their interpretation; electronic instrumentation; standard forms and reporting techniques; demonstrations of all types of commercial load-testing apparatus for flexible parts; and the use of the standard f-d curve.

# ASME Junior Forum

Compiled and Edited by a Committee of Junior Members, C. H. Carman, Jr., Chairman

## Engineering Societies Personnel Service

ARE you one of many engineers who have good positions and are happy in their work? Perhaps you fall in the group that feels a change in job would be wisest. Whether you are satisfied with your present position or not, the following is of importance to all junior members. This article is written in the interest of helping junior members to further their aim of advancing in the engineering field by obtaining employment commensurate with their abilities and desires.

It is a well-known fact that many men chosen for good positions were not unemployed, but simply looking for promotion. In many cases it is not always possible to obtain advancement within one organization and often the only practical way is to change employers. The Engineering Societies Personnel Service is a nation-wide organization which offers its facilities to men interested in such a course of action. It is jointly managed by the Founder Societies: ASCE, AIEE, ASME, and AIME. Offices of the Service can be found in New York, Chicago, Detroit, and San Francisco. The organization is operated on a nonprofit basis and its services are available to all engineers whether they are affiliated with the sponsoring societies or not.

Engineers desiring to register with the service may do so by visiting or writing the office nearest them. When the completed application is received by the Service, it will be indexed and filed according to the applicant's experience and type of work he is interested in. A list of available positions is published and can be obtained in three ways. First, the magazines sponsored by the Founder Societies list the positions relative to their fields in every issue. Secondly, a list of openings is always available to persons visiting the offices of the Service. There is also a bulletin published listing the openings which is mailed to subscribers. The bulletin is especially helpful for the positions that can be applied for by letter and for persons who cannot make personal applications for positions but must do so by correspondence. This bulletin service can be obtained in all states except the State of New York. According to Alfred H. Meyer, member ASME, director of the Service, approximately 40 per cent of all placements are made through use of the bulletin.

As information on available positions is received by the Service it is listed geographically, and all openings for one area are sent to the office in that area. Upon receipt of the positions, all active applicants are reviewed and résumés of qualified men are sent to employers. The employer may then contact the Service or the applicant directly. Mr. Meyer points out that since 1940 approximately 30 per cent of all applicants have obtained positions through the Engineering Societies Personnel Service. In 1947 some 2500 applications were received.

The problem of finding the proper employment and getting one's feet on the ground with a sound foundation of engineering experience is of great importance to the junior engineer. The Engineering Societies Personnel Service offers its facilities to you for this purpose. Naturally, it is to the engineer's benefit that this mutually sponsored service operate in the most efficient manner possible. Any suggestions and comments toward that end would be appreciated. All letters should be sent to the "Junior Forum."

Burton Scheimman.[2]

### The Executive Ladder

IN general a man is made an executive not because he is outstanding in any respect but because the other candidates are badly lacking in some essential quality.[1]

## Making the Most of Engineering

THE following paragraphs are excerpts from a speech by James C. Zeder, Fellow ASME, chairman, engineering board, Chrysler Corporation, presented before a meeting of the Detroit Section, Society of Automotive Engineers, May 19, 1947.

What strikes me so forcibly is this—how much more successful most of us would be as engineers if, at the same time, we were somehow able to be more successful as individuals.

What we as engineers too often overlook is the fact that our individual success is measured not only by how much we know, but of even greater importance, how much of our information we can pass on to others and how much of it gets into actual use.

It's not easy to take an objective view of personal obstacles, because when people oppose us, the most natural thing is to get upset. We have all kinds of energy to pour into impatience, anger, resentment, suspicion, and injured pride; but it's something else again to force our thoughts into channels of analysis, unprejudiced judgment, enterprise, and constructive action in spite of disturbing circumstances.

Walt Whitman asks, "Have you learned lessons only of those who admired you and were tender with you, and stood aside for you? Have you not learned great lessons from those who braced themselves against you, and disputed the passage with you?"

There are various types of work to be done, but as a company grows in size, the more necessary it becomes that people must fit themselves to jobs rather than that jobs can be created to fit people.

Technical proficiency, alone, is not enough. The most widespread and useful characteristic of success is the ability to get along with people. That doesn't mean being an easy mark—letting others run over you.

Here's a second characteristic of successful people—it's their habit of looking beyond their own department, or their own activity, and the object is seldom to locate greener pastures. They've discovered that their own market value goes up whenever they extend their services.

What can we, personally, do about it? Each of us can make more progress in engineering if he is willing to carry on a serious program of self-development and self-adjustment.

## ASME Junior Committee Meets

THE place of junior members on ASME national committees and the policy for encouraging organization of Junior Groups in ASME Sections came up for discussion at the seventh meeting of the Junior Committee held in the rooms of the Society, Feb. 14, 1948.

As a result of the meeting, the Committee is undertaking a study of problems involved in appointing junior members to serve as junior advisers to ASME committees. What will be sought particularly will be answers to the following questions: How many committees can use junior advisers? What is the best

### Education

ENGINEERING colleges teach much theory because sound theory is the most fundamental, basic, and durable knowledge, hence the best foundation for a useful professional life in a changing world.[1]

[1] New Proverbs for Young Engineers, by Philip W. Swain, editor, *Power*, McGraw-Hill Publishing Company, Inc., New York, N. Y. Member ASME.

[2] Mechanical Engineer, Republic Aircraft Corporation, Farmingdale, N. Y. Jun. ASME.



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### Getting Along

Average technical ability multiplied through co-operative effort accomplishes more than great talent working alone.[1]

procedure for appointing juniors for committee service? Does a junior member actually benefit from such service?

In the discussion on the Society policy on Junior Groups, the point was made that while the larger sections may find the organization of a Junior Group a stimulus to junior-member participation, smaller sections where membership is less than 200 may find that a junior-group program would only serve to weaken the section program and therefore was not desirable. Others felt that however small a section may be, active enthusiastic junior members were an asset which could be turned to good account by organizing these young men and directing their energy into the best channels.

The following seven points were agreed upon as a tentative basis for a Society policy on Junior Groups:

1 Regardless of size of section, the objectives should be to secure active participation of the juniors in the section activity and to provide them with support necessary to aid them to grow in their professional lives.

2 Each section should have a nucleus of older men interested in the juniors.

3 Where the size of the section permits, separate Junior Groups should be organized but care should be taken to see that Junior Groups continue to be made up of juniors.

4 In all sections, juniors should be given operating responsibilities and training.

5 In all sections, opportunities should be sought to provide organized training and lecture groups for the juniors.

6 In the small sections, where an organized group of juniors may be impractical, opportunity should be sought to facilitate the acquaintance among the juniors themselves.

7 In each section, regardless of size, at least one junior should be appointed to stimulate all activities of interest to the juniors in the Section.

### Skill

THE most important branch of engineering mathematics is arithmetic.[1]

## A Project for Junior Groups

According to the Engineer's Society of Milwaukee, men in the Veterans' Hospitals have been asking for magazines of a technical nature. While plenty of literature of the popular variety is made available to them, engineering and scientific journals are not often contributed.

Since there are Veterans' Hospitals in every Region of the ASME this situation offers an opportunity for service to ASME junior members. Why not organize a library committee to contact the local hospitals? Most engineers in the community have engineering books and publications which they may be glad to contribute to such a worthy purpose.

An appeal of this kind made by the engineers of Milwaukee, Wis., won the enthusiastic support of the community. Engineers everywhere will want to participate in similar projects.

## *Junior Activities*

### Boston Section

The first step in the formation of a Junior Group was taken recently by the Boston Section when Robert Nelson, Charles T. Miller, and Robert F. Metcalf, Jr., were appointed to form a committee for the purpose of planning a program for junior members. The action was the result of encouragement by Frank M. Gunby, vice-president, ASME Region I, and E. G. Bailey, president ASME. The new committee needs the support of all junior members in the Boston Section.

Those who want to help in the junior program are invited to write to Prof. A. J. Ferretti, secretary, ASME Boston Section, Northeastern University, Boston, Mass.

### Chicago Section

In the ASME Chicago Section, junior members participate in all plans of section activity. For example, there are junior members on all the standing committees. Each professional division and each operating committee has a junior co-chairman. There are three junior members on the executive committee.

In addition to supporting regular section programs, the Junior Group has its own organization with two chairmen and an executive committee. This group conducts its own programs which parallel those of the section. Junior and senior members participate alike in all meetings of the Section and the Junior Group.

During 1947–1948 the Junior Group conducted two inspection trips, two discussion meetings, and several dinner meetings, and soon they expect to be hosts to E. G. Bailey, president ASME, who will speak to them on an important subject. For this meeting the Junior Group has invited student members from two near-by engineering colleges.

### St. Joseph Valley Section

In the St. Joseph Valley Section the junior-member situation is quite different. Since there are only 80 members in the Section, the number of junior members is so small that independent activities are not practicable. Currently the Section is trying to stimulate interest in section activities and junior members are prominent in this project. W. McKlean White, Jr., junior member ASME, who is secretary-treasurer of the Section, feels that a single program of interest to all grades of membership is the best method of developing interest in Society activities in his Section.

### South Texas Section

The Junior Group of the South Texas Section held a meeting on Feb. 12, at the Rice Institute, Houston, Texas. The speaker was Mr. Owens of the Tennessee Gas and Transmission Company, whose subject was "Construction of Long-Distance Gas Pipe Lines." Mr. Owens gave a short history of his company and the reasons for constructing the line. He then showed a 30-minute film on the construction of the TG&T Company 24-in. gas pipe line from Sweetwater, Texas, to the Atlantic Coast. This film was in technicolor. After the meeting Mr. Owens conducted a discussion period. Attendance: 23.

## French Engineers Celebrate Centennial

THE ASME was invited to participate in the celebrations marking the centenary of the founding of the Société des Ingenieurs Civil de France to be held in Paris, May 29–June 3, 1948.

Opening with an address of welcome by Vincent Auriol, president of the Republic, the program will consist of technical sessions, lectures by eminent scientists, and inspection trips to the important dams, bridges, and industrial plants of France.

# Actions of the ASME Executive Committee

### At a Meeting Held at Headquarters, Feb. 19, 1948

A MEETING of the Executive Committee of the Council was held in the rooms of the Society, February 19, 1948. There were present: E. G. Bailey, chairman, F. S. Blackall, Jr., F. M. Gunby, J. N. Landis, T. E. Purcell, of the Executive Committee; E. J. Kates and A. R. Mumford, members of the Council; K. W. Jappe, treasurer, C. E. Davies, secretary, and Ernest Hartford, executive assistant secretary.

#### History of ASME

It was voted to request the Publications Committee under the guidance of the Board on Technology to prepare a plan for a history of the ASME as a corporate body. An estimate

of costs, suggestions for possible authors, and some idea of expected sale of the volume was requested.

### Preprints of ASME Papers

A recent action by the Board on Technology abandoning the practice of distributing free advance copies of papers at technical sessions of ASME National meetings was noted.

### Registration Fees

Upon recommendation of the Board on Technology, it was voted to continue the $5 registration fee for nonmembers at four general meetings of the Society during 1947 and 1948, but to extend exceptions as follows: (1) Nonmember authors; (2) nonmembers formally invited to discuss a paper; and (3) nonengineer members of the immediate family of a member.

### Materials-Handling Exhibition

Recent action by the Board on Technology approving the idea of an ASME arranged technical program in connection with the Materials-Handling Exhibition to be held in 1949 was noted.

### Revision of ASA Constitution

Upon recommendation of the Board on Codes and Standards, the "enabling amendment for incorporation" to the constitution of the American Standards Association was approved. The amendment permits incorporation of the ASA as a membership corporation by vote of not less than three fourths of its members.

### ASME Fall Meeting

It was noted that meeting rooms for the ASME Fall Meeting had been secured without charge to the Society at Reed College, Portland, Ore., and that the meeting will be held as originally scheduled.

### Nominating Procedure

A statement on ASME nominating procedure prepared with the assistance of recent chairmen of the Nominating Committee was approved for publication in Mechanical Engineering. The statement is published on page 378 of this issue.

### Southern Tier Section Affiliation

Affiliation of the Southern Tier Section with the Technical and Engineering Council, Societies of the Southern New York Area, was approved but with the understanding that financial responsibilities incurred in the new relationship were the sole responsibility of the Section.

### Student Branch Transfers

Letter ballot approval of the following Student-Branch transfers was confirmed: University of Louisville and University of Kentucky from Region IV to Region VI; University of Nebraska from Region VI to Region VIII.

### Certificates of Award

Certificates of Award for the following were approved: Thomas H. Wickenden, Admissions Committee; W. F. Stewart, Mid-Continent Section; J. F. Ransom, Colorado Section; C. W. Obert and James Partington, Boiler Code Committee.

### Engineering Profession

After discussing the problem of the organization of the engineering profession at great length, it was voted to authorize the transmission of the Engineers Joint Council Report on the Organization of the Engineering Profession on to the Sections for their consideration and comment to the Council through the Regional Delegates Conference.

### EJC Constitution

The draft of the new constitution of the Engineers Joint Council submitted to the Society for consideration, was approved in principle.

### EJC Consultative Committee

E. G. Bailey and R. M. Gates were appointed as ASME representatives of the National Engineers Consultative Committee of the Engineers Joint Council. The Committee was established by the EJC to carry on the functions of the Consultative Committee to the Secretary of State and the former National Engineers Committee, and to handle requests for aid from administrative agencies of the Federal government.

### Thomas A. Edison Foundation

Upon invitation of the Thomas Alva Edison Foundation, Inc. for ASME to participate in the projects of the Foundation, it was voted to appoint five representatives of the Society to co-operate in the proposed projects and to permit the use of the ASME mailing list but with the understanding that the Society will not be required to contribute financially.

### Deaths

The deaths of Orville Wright and George R. Bateman were noted with deep regret.

### Appointments

The following appointments were confirmed: Knight Pryor, Sesquicentennial Celebration, University of Louisville; F. M. Gunby, dinner commemorating centennial, Lawrence Scientific School; C. B. Campbell and M. C. Randall, annual meeting, American Academy of Political and Social Sciences.

# Section Activities

### Akron-Canton

Feb. 26, dinner meeting, Women's City Club, Akron, Ohio. Speaker: Milo Dean, chief engineer, Greyhound Corporation, Chicago, Ill. Subject: Intercity Bus Design and Development. Attendance: 111.

### Baltimore

Jan. 26, dinner and meeting. Speaker: E. G. Bailey, president ASME. Subject: Opportunities for The Young Engineer. Attendance: 150.

### Boston

Feb. 18, MIT Graduate House, Cambridge, Mass. Speaker: R. H. Davies, consulting engineer, Lincoln Electric Company. Subject: Design of Weldments for the Machinery Industry. Attendance: 130.

### Buffalo

Jan. 15, Park School of Buffalo, Snyder, N. Y., dinner and meeting sponsored by the heat-transfer committee of the Section. Speakers: James Fullman, consulting engineer, A. M. Byers Company, New York, N. Y., "Radiant Heating;" G. W. Brown, engineering commercial division, air-conditioning department, General Electric Company, Bloomfield, N. J., "Heat Pumps." Attendance: 180.

### Central Indiana

Feb. 20, Canary Cottage, Indianapolis, Ind. Joint meeting with the Indiana Section of the Society of Professional Engineers. Speaker: Wm. A. Hanley, past-president and Fellow ASME, vice-president, Eli Lilly & Company, Indianapolis, Ind. Subject: Management. Attendance: 109.

### Central Iowa

Feb. 17, Younkers Tea Room, Des Moines, Iowa. Speakers: J. M. Drabelle, member ASME, Mr. Brown, and J. S. Mikovec, junior member ASME. Subjects: Steam and Diesel Developments; REA and Electrical Developments; and Power Developments in Industry. Attendance: 69.

### Chicago

Feb. 11, Furniture Club of America, Chicago, Ill. Speaker: Senator Ralph E. Flanders, past-president and honorary member ASME. Subject: Technology and Living Standards. At this meeting the 1948 Washington Award to Senator Ralph E. Flanders, sponsored by Western Society of Engineers and the four Founder Societies, was made. The citation read "for high technical skill in perfecting the tools of industry and for distinguished service in the field of human relationships."

Feb. 19, Chicago Engineers Club, Chicago, Ill. Speakers: Prof. W. R. Spriegel, Northwestern University, and Owen Fairweather, lawyer. Subjects: The Taft-Hartley Act, and Save Labor or Slave Labor Act. Attendance: 97.

### Cincinnati

Feb. 5, Engineering Societies Building, Cincinnati, Ohio, dinner and program. Speaker: W. Julian King, member ASME, director, Sibley School of Mechanical Engineering, Cornell University, Ithaca, N. Y. Subject: Personal and Professional Problems of Engineers. Dinner speaker: Dean C. A. Joerger, member ASME, University of Cincinnati School of Engineering, who described the tremendous contribution made by John T. Faig, Fellow ASME, president of Ohio



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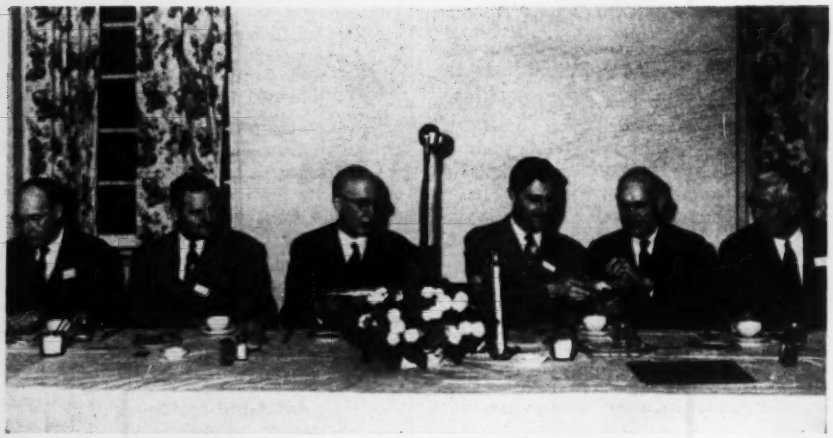

DINNER MEETING OF THE ASME BALTIMORE SECTION, JAN. 26

(*Left to right:* Prof. A. G. Christie, past-president and honorary member, ASME; S. F. Robertson, vice-chairman, Baltimore Section; E. G. Bailey, president ASME, E. G. Hanhart, chairman, Baltimore Section; Prof. P. B. Eaton, vice-president, ASME Region III; and R. L. Thomas, Baltimore Section.)

Mechanics Institute, to local and national ASME and engineering progress. Attendance: 125.

### Cleveland

Feb. 12, Warner Auditorium, Cleveland Engineering Society headquarters, Cleveland, Ohio. Speaker: John W. May, member ASME, development engineer, Wright's Automatic Machinery Corporation, Durham, N. C. Subject: Mechanisms. Attendance: 300.

### Detroit

Feb. 11, Rackham Memorial Building, Detroit, Mich. Speakers: R. M. Van Duzer, Jr., member ASME, and George B. Emery. Subjects: First, Japan; second, Future Planning for Detroit. Attendance: 240.

### Fairfield County

Feb. 18, Hotel Barnum, Bridgeport, Conn. Speaker: George O. Clifford. Subject: Cutting Tomorrow's Cash. Attendance: 155.

### Fort Wayne

Feb. 5, Chamber of Commerce, Fort Wayne, Ind. Speaker: Richard Lowe, senior mechanical-engineering student, Indiana Tech. College. Subject: Panel Heating and Heat-Pump Applications. Attendance: 32.

### Hartford

Feb. 17, Ladies' Night, City Club, Hartford, Conn. Speaker: Dr. Frank Yourga. Subject: Bottles Versus Botulism. Attendance: 50.

### Metropolitan

Feb. 11, Engineering Societies Building, New York, N. Y. Speaker: A. R. Mumford, vice-president, ASME Region II, development engineer, Combustion Engineering Company, New York, N. Y. Subject: Objectives of the ECPD. Attendance: 50.

Feb. 24, Engineering Societies Building, New York, N. Y. Speaker: Fenton B. Turck, member ASME, president, Turck, Hill and Company, New York, N. Y. Subject: Opportunities for the Engineer in Distribution. Attendance: 150.

### Nebraska

Jan. 21, WOW Building, Omaha, Neb. Joint meeting with the Engineer's Club of Omaha. Speaker: Prof. Niles H. Barnard, member ASME, associate professor, University of Nebraska. Subject: Technical Skill Requirements in Nebraska. Attendance: 70.

### North Texas

Feb. 12, SMU, Union Building, Dallas, Tex. Speaker: O. H. Somers, Standard Gage Company. Subject: Tools for Dimensional Quality Control. Attendance: 20.

### Ontario

Feb. 12, Hart House, University of Toronto, Toronto, Ont., Can. Speaker: Forrest Nagler, member ASME, chief mechanical engineer, Allis-Chalmers Manufacturing Company. Subject: Bikini—The Human Side. Attendance: 207.

A. R. MUMFORD, VICE-PRESIDENT, ASME REGION II, PRESENTS ADOLPH EHBRECHT (*right*) WITH A CERTIFICATE OF AWARD IN RECOGNITION OF HIS SERVICES TO THE ASME METROPOLITAN SECTION

(The ceremony took place on Feb. 11, 1948, during a meeting of the Metropolitan Section Engineers' Forum, an organization which Mr. Ehbrecht helped to organize in 1932 to give engineers an opportunity to practice public speaking. Officers of the Section and many of Mr. Ehbrecht's friends were present for the occasion.)

### Oregon

Feb. 18, Board of Directors' room, Public Service Building, Portland, Ore. Speaker: Sidney Nashner, plant superintendent, Columbia Metals Corporation, Salem, Ore. Subject: Construction and Operation of Electric Steam Boiler Used to Produce Alumina From Oregon Clays. C. J. Rosne, electrical engineer, Columbia Metals Corporation, discussed the more detailed electrical aspects of the system. A film "Steam Progress," was shown by G. P. Ellis, member ASME, Pacific Coast representative for the Combustion Engineering Company, which portrayed the development of steam boilers and illustrated some of the high-capacity equipment now being installed. Attendance: 27.

### Philadelphia

Feb. 17, University of Pennsylvania, Philadelphia, Pa. Speaker: Harry W. Pierce. Subject: Welding From the Mechanical Engineer's Viewpoint. Attendance: 50.

Feb. 24, Engineers' Club of Philadelphia, Philadelphia, Pa. Speaker: W. Julian King, member ASME, director, Sibley School of Engineering, Cornell University, Ithaca, N. Y. Subject: Professional and Personal Problems of the Engineer. Attendance: 86.

### Rochester

Feb. 12, Hotel Sheraton, Rochester, N. Y. Speaker: Jack T. Temin, commerce engineer, Tocco division, Crank Shaft Company, Cleveland, Ohio. Subject: Industrial Heating—Unveiled. Attendance: 50.

### St. Louis

Feb. 27, Garavelli's Restaurant, St. Louis, Mo. Speaker: Allen W. Clarke, American Car and Foundry Company. Subject: New Railroad Passenger Cars. Attendance: 65.

### Southern Tier

Feb. 23, New York Institute of Applied Arts and Sciences, Binghamton, N. Y. Speaker: John Forrest, of ANSCO. Subject: Color Photography. Attendance: 32.

### South Texas

Feb. 26, The Rice Institute, Houston, Tex. Speaker: John R. Carlson, member ASME, Westinghouse Electric Corporation. Subject: Latest Developments in Steam and Gas Turbines. Attendance: 225.

### Virginia

Feb. 27, Pythian Castle, Norfolk, Va. Speaker: John C. Messick, chief engineer, service division, Langley Memorial Laboratory, and representative of the Contracting Officer. Subject: Engineering Problems of an Aeronautical Research Laboratory. Attendance: 116.

### Waterbury

Feb. 3, University Club, Hotel Elton, Waterbury, Conn. Speaker: W. I. Benz. Subject: Electronics in Industry. Attendance: 50.

"GREASE BALL," ANNUAL EVENT OF THE ASME STUDENT BRANCH OF THE COLORADO A&M COLLEGE

### Worcester

Feb. 20, Worcester Polytechnic Institute, Worcester, Mass. Speaker: Hartwell G. Howe, Heald Machine Company, Worcester, Mass. Subject: Precision Boring Machines and Their Applications. Attendance: 40.

### Youngstown

Feb. 12, Inspection trip to Republic Rubber Company, Youngstown, Ohio. Host: Clarence E. McCormick, chief engineer of the company. Refreshments were served during the trip. Attendance: 105.

# Student Branch Activities

### University of Akron

Jan. 20, business meeting. Presiding officer: Robert J. Harry. Attendance: 17.

Jan. 22, trip through the Quaker Oats Company's plant. Attendance: 20.

### Alabama Polytechnic Institute

Jan. 12, Ramsey 200. Presiding officer: Mr. Bounds. General business meeting. Attendance: 65.

Jan. 26, Ramsey 200. Speaker: Mr. Reitmeyer. Subject: Sales Engineering. Attendance: 120.

Feb. 9. Program: Three talks on oil fields and oil production by three student members—Leonard Braswell, Ralmadge Blair, and Sam Bounds, chairman of the branch. Attendance: 50.

Feb. 23. Program: Film showing the construction of the San Francisco-Oakland Bay Bridge. Attendance: 40.

### University of Arizona

Feb. 5, Administrative Building. Presiding officer: Robert Brown. Program: Film entitled "Die Casting," product of the New Jersey Zinc Company. Attendance: 42.

Feb. 13, Library. Joint meeting of the engineering societies of the University. Speaker: Capt. A. A. Nichoson, veteran of World War I, and assistant to vice-president, Texas Company. Subject: The Engineer's Place in the World of Tomorrow. Attendance: 90.

### Colorado A&M College

Jan. 19, Civil Engineering Auditorium. Joint meeting with ASCE and AIEE. Speaker: Robert T. MacCalmon, field-service engineer, A. M. Byers Company. Subject: Radiant Heating, illustrated with a film entitled "Forever Yours," depicting the manufacture of wrought iron.

Feb. 2, Mechanical Engineering Building. Program: "Treasure From the Sea," film of the Dow Chemical Company, illustrating the uses and advantages of magnesium.

### University of Colorado

Feb. 10, Old Main Chapel. Presiding officer, Gene Grieshaber. Program: Technicolor film on the development of steam power. Attendance: 26.

### Columbia University

Feb. 27, room 208 Pupin, mechanical division of the Branch. Program: Film entitled "Steam Power for American Sea Power," made by Babcock and Wilcox Company on the production of steam boilers for destroyers. Talk by Prof. William Hadley, junior member ASME, mechanical-engineering department, on various fields of mechanical engineering, and the opportunities for engineers upon graduation. Attendance: 42.

### University of Connecticut

Feb. 18, election of officers for the present semester. New chairman, Carlton P. Perrin.

### University of Delaware

Feb. 12. Speaker. John I. Yellott, member ASME, director of research, Locomotive Development Commission, Baltimore, Md. Subject: Recent Developments in Gas-Turbine Research. Attendance: 200.

### University of Detroit

Feb. 11, Inspection trip to Great Lakes Steel Company's plant, Ecorse, Mich., conducted by members of the engineering staff of that company. Attendance: 37.

### Drexel Institute of Technology

Feb. 4, Student Building. Presiding officer: William J. Bayer. Program: Films loaned by the Bethlehem Steel Company; the first, "High Lights in Steelmaking;" the second, "Construction of the Golden Gate Bridge." Attendance: 25.

Feb. 18, Student Building. Speaker: Norman L. Smith, member ASME, engineer, Link-Belt Company. Subject: Modern Foundry Methods, illustrated with slides and motion pictures. Attendance: 35.

DINNER MEETING OF THE ASME STUDENT BRANCH OF THE UNIVERSITY OF CONNECTICUT

(*Left to right:* C. P. Perrin, chairman, ASME Student Branch; A. I. McKee, design director, Electric Boat Company, Groton, Conn., Mrs. McKee, and Prof. C. H. Coogan, head, mechanical-engineering department, University of Connecticut.)



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AT A MEETING OF THE ASME STUDENT BRANCH OF UNIVERSITY OF DELAWARE

(*Left to right:* John Dick, president; Lieut. James Echeverria, secretary; Prof. James I. Clower; and Dr. John Yellott.)

### Georgia School of Technology

Feb. 2, Mechanical Engineering Building. Speaker: Arthur L. Harris, president, Atlantic Paper Company. Subject: Opportunities for Mechanical Engineers in the Paper Industry. Attendance: 96.

### University of Illinois

Feb. 18, Engineering Hall. Presiding officer: Wm. McCarthy. Program: Film on Die Casting. Election of officers for the new term. Robert Plumb was elected to represent the branch as its contestant for St. Patrick in the contest to be held at the St. Patrick's Ball. Attendance: 71.

### Iowa State

Feb. 11, Marston Hall Assembly. Speaker: Mr. Vernon, sales-promotion manager, Johnson Service Company. Subject: Opportunities, Requirements, and Qualifications for Sales Engineering. Attendance: 160.

### University of Kansas

Feb. 19, Lindley Auditorium. Joint meeting with ASCE and AIEE. Speaker: E. B. Black, Black and Veatch, consulting firm, Kansas City, Mo. Subject: Professional Problems of Engineers. Attendance: 138.

### University of Kentucky

Jan. 29, room 235, Mechanical Hall. Presiding officer: J. L. Morrissey. Discussion of prospective programs for future ASME assemblies.

Feb. 5, Training School Auditorium. Speaker: Dr. Roy Moreland, Law College of the University. Subject: Odds and Ends. Attendance: 267.

Feb. 19, Training School Auditorium. Presiding officer: J. L. Morrissey. Program: Discussion of conditions inside Yugoslavia. Attendance: 274.

Feb. 26, Training School Auditorium. Speakers: Prof. W. M. Carter, and Prof. E. B. Penrod, member ASME. Subjects: Local Speakers' Contest for ASME technical papers, and discussion of change-over from the "quarter" to the "semester" system of the college of engineering.

### Lafayette College

Feb. 10, presiding officer: Elmer Aldington. Speaker: Francis G. Tatnall, Baldwin Locomotive Works. Subject: Making Structures Stronger by Making Them Lighter. Attendance: 250.

### Lehigh University

Jan. 15, Packard Laboratory. Speaker: R. Allen Price, chief of flight test, Bell Aircraft Corporation. Subject: Helicopters. Attendance: 120.

Feb. 19, Packard Laboratory. Speaker: George M. Keenan, chief engineer, Pennsylvania Power and Light Company, Allentown, Pa. Subject: Construction and Future Use for the Nearly Completed Sunbury Steam-Electric Station, a New 150,000-Kw Source in a 5,000,000-Kw Power-Supply System. Attendance: 100.

### University of Michigan

Feb. 18, Michigan Union. Speaker: Tom Kinkead of Central Specialties Company, Ypsilanti, Mich. Subject: Phases of Industrial Labor Relations. Attendance: 63.

Feb. 25, Natural Science Auditorium. Program: Two movies: first, "The Making and Shaping of Steel," by the U. S. Steel Corporation; second, "Steam Progress," by Combustion Engineering Company. Attendance: 195.

### University of Minnesota

Feb. 4, inspection trip with members of the ASME Minnesota Section to plant of the Minneapolis-Moline Power Implement Company.

Feb. 18, Coffman Memorial Union. Presiding officer: Harold Danforth. Election of officers. Attendance: 50.

### Mississippi State College

Feb. 5. Presiding officer, W. A. Bartholomew. Program: Film "Eternally Yours," dealing with wrought iron. Attendance: 49.

Feb. 19. Presiding officer, W. A. Bartholomew. Program: Color film entitled "Die Casting." Attendance: 51.

### University of Missouri

Feb. 5, room 109, Engineering Hall. Presiding officer, Walter Roesener. Speaker: C. C. LaVene, employment manager, engineering division, Douglas Aircraft Company, Inc. Subject: Opportunities for Engineers in the Aircraft Industry. Attendance: 66.

### University of Nebraska

Feb. 18, 206 Richards Laboratory. Speaker: Carl Stuermer, Elgin Watch Company. Subject: Industrial Engineering.

### University of New Mexico

Feb. 10. Presiding officer: J. Hall. General business meeting. Attendance: 24.

### New York University

Feb. 16, evening division. Presiding officer: Prof. E. Salma, member ASME. Program: Film "The Magic of Steam." This gave a general idea of the use of the impulse and reaction principles in manufacture of steam turbines. Attendance: 20.

### North Dakota Agricultural College

Jan. 22, room 15, Engineering Building. Program: Film entitled "Steam-Power Progress," product of Combustion Engineering Company, Inc. Attendance: 46.

### Northeastern University

Feb. 5, 440 Richards Hall. Presiding officer, Mathew Reiser. Program: Two films, the first, "The Story of A-C Arc Welding for the Operator," and "The Inside of Atomic-Hydrogen Arc Welding," products of General Electric Company. Attendance: 51.

Feb. 12, room 200, Richards Hall. Speaker: Mr. Edmunds, representative from the Socony-Vacuum Oil Company, who illustrated his talk with a film, "The Inside Story," on principles of lubrication covering gears, shafts, chains, and bearings. Attendance: 50.

### University of Oklahoma

Feb. 3, Engineering Auditorium. Presiding officer, Robert M. Wright. Election of new officers. Presentation of combination cigarette and pipe lighter to Prof. E. F. Dawson, member ASME, past honorary chairman, in token of appreciation for his outstanding services as honorary chairman. Program: Three educational films: "Weather;" "The Milling Machine;" and "The Manufacture of Paper." Attendance: 36.

### Ohio State University

Feb. 12, Robinson Laboratory. Presiding officer: Gilbert C. Morris. Program: Film entitled "Building the Golden Gate Bridge," with comments by Prof. J. R. Shank of the department of civil engineering.

Feb. 26, Robinson Laboratory. Program: Student Speakers' Contest was held and Merrill F. Yale was awarded first prize for his speech "The Trial Trip of the S. S. *America*." Second prize to Frank Straus for his speech "Atomic Energy Is Here to Stay." Third prize to Jack Engelhart for his talk "What the Steel Industry Has to Offer Engineering Graduates." Attendance: 52.

### Oregon State College

Jan. 29, Chemistry 201. Program: Two films: first, "The Amazing Legacy of Rudolph Diesel," product of the Standard Oil Company; second, "The Modern Magic Carpet," product of the Bell Aircraft Company. Attendance: 70.

### Pennsylvania State College

Jan. 20, Main Engineering Building. Speaker: Prof. Edward N. Baldwin, who holds the Westinghouse professorship at Penn State. Subject: Production Engineering. Attendance: 50.

Feb. 17. Speaker: F. R. Ellenberger, General Electric Company. Subject: The Heat Pump for Domestic Heating. Attendance: 130.

### Rensselaer Polytechnic Institute

Feb. 12, Sage Laboratory. Speaker: Newell Freeman, engineering board for licensing professional engineers in New York State. Subject: Licensing of Professional Engineers. Attendance: 105.

### University of Rochester

Feb. 19, Engine House. Presiding chairman: Tom Hoffman. Program: Film entitled "Tornado in a Box," product of the Allis-Chalmers Manufacturing Company. Attendance: 30.

### Rose Polytechnic Institute

Feb. 26, assembly room. Presiding officer: George N. Blount. General business meeting, at which membership pins were given to new members. Attendance: 42.

### Rutgers University

Feb. 11, Engineering Building. Presiding officer: Tom Gedettis. It was voted to start an engineering magazine at Rutgers. Attendance: 27.

### University of Southern California

Feb. 12, room 102. Annex. Presiding officer: William L. Holmes. Outline of program for the new semester was discussed. Attendance: 17.

### Texas A&M College

Feb. 24, Mechanical Engineering Building. Election of officers. Speaker: Fred Moller, member ASME, South Texas Section. Subject: Problems Shared. Attendance: 41.

### University of Texas

Feb. 9, Engineering Building. Joint meeting with ASCE. Speakers: P. E. Cunningham, senior engineer, Vicksburg Engineering District, and C. T. Conley, training engineer for the District. Subject: Flood Control on the Lower Mississippi, illustrated with a film. Attendance: 30.

Feb. 23, Engineering Building. Program: Film "Steam Progress," product of the Combustion Engineering Company, showing various types of boiler and methods of constructing them. Attendance: 45.

### University of Toronto

Feb. 12, Hart House. Joint meeting with ASME Ontario Section. Speaker: Forrest Nagler, member ASME, chief mechanical engineer, Allis-Chalmers Manufacturing Company. Subject: Bikini—The Human Side. Attendance: 205.

### Tufts College

Jan. 18, Robinson Hall. Election of officers for the spring term. Attendance: 52.

### Virginia Polytechnic Institute

Feb. 10, inspection trip to the Radford Weaving Company's plant, Radford, Va., and the Appalachian Electric Power Company's hydroelectric plant, Claytor Dam. Attendance: 83.

Feb. 17, Building 362. Speaker: D. B. Dunlevey, director of placement office at Virginia Tech. Subject: The Placement Office and Qualifications Which Most Companies Expect of a College Graduate. Attendance: 165.

### University of Washington

Feb. 12, Guggenheim Hall. Speaker: Mr. Philbrick, instructor in the mechanical-engineering department at the University. Subject: Third of a series of talks on job procurement by the same speaker. Attendance: 42.

### Wayne University

Feb. 12, Webster Hall. Speakers: Irving Moser and John F. Ostergren of Westinghouse Electric Corporation. Subjects: First, Fuel Nozzles Used in Gas Turbines; second, Gas Turbine, illustrated with colored slides. Attendance: 54.

### West Virginia University

Feb. 19, Reynolds' Hall. Presiding officer: Russell L. Dalton. General business meeting. Attendance: 50.

March 2, Reynolds' Hall. Brief business meeting preceding a meeting of the General Engineering Society. Speaker for the General Engineering Society: Joe Van Vooris, Clarksburg, W. Va. Subject: Engineer's Civic Responsibilities. Attendance: 30.

### University of Wyoming

Feb. 16, Engineering Building. Speaker: Dr. E. S. Wengert, head of the political-science department at the University, and consultant to the U. S. Atomic Energy Commission. Subject: United Nations Organization. Attendance: 32.

## ASME Sections

### *Coming Meetings*

*Akron-Canton:* April 15. Dinner 6:30 p.m.; lecture 8 p.m. Symposium: On the Design and Manufacture of Rubber Tires. The Rubber Companies have been invited to provide speakers.

*Atlanta:* April 5. 12 noon, luncheon meeting of the Georgia Engineering Society.

*Central Pennsylvania:* April 7. Inspection trip to machine shops, assembly floor, and foundry of the Chambersburg Engineering Company, followed by an inspection of the reclamation plant of the Pennsylvania Railroad Company at Chambersburg. This will be followed by a paper, Forging: Its Broad Practices and Economic Significance, by A. M. Steever, general superintendent, Columbia Tool Steel Company.

*Chicago:* April 7, 8, and 9. Sheraton Hotel. Midwest Power Conference. Subject: New Appraisal of Fuel Situation, by John Van Brunt, vice-president in charge of engineering, Combustion Engineering Company, New York, N. Y., and Problems in Dynamics of Machines, by A. C. Hagg, manager, dynamics section, mechanical department, Westinghouse Electric Corporation.

*Cleveland:* April 8. Case Institute of Technology at 6:30 p.m. Annual meeting with Case Student Branch. Elmer L. Lindseth, president of Cleveland Electric Illuminating Company, will speak.

*Columbus:* April 8. Battelle Memorial Institute at 8 p.m. Joint meeting with the Ohio State University Student Branch.

*Detroit:* April 13. Rackham Educational Memorial Building, 8 p.m. Subject: Future of Atomic Power, by Philip W. Swain, editor, *Power*, New York, N. Y.

*Fairfield County:* April 21. Hotel Barnum, Bridgeport, Conn., 8 p.m. Subject: Three-Dimensional Pictures, by Floyd A. Ramsdell, Worcester Film Corporation.

*Metropolitan:*

April 6. Junior Group Meeting, Room 502[1] at 7:30 p.m.

April 7. General Interest Meeting, Room 502[1] at 7:30 p.m. Subject: Industrial Engineering for Safety, by H. A. Cozzens, Jr., adjunct professor of administrative engineering, New York University.

April 7 and 8. Regional Administrative Committee Meeting, Room 1101[1] at 7:15 p.m.

April 8. Woman's Auxiliary Luncheon, Fraunces Tavern, Broadway and Pearl St., New York, N. Y., at 11:45 a.m. Price $2.

April 8 and 9. Third Annual Joint ASME-SAM Meeting. Time Study and Methods Conference, Hotel Pennsylvania at 9:30 a.m.

April 9. Joint Meeting ASME-American Rocket Society, Room 501[1] at 7:30 p.m. Subject: Swiss Gas-Turbine Developments, by Frances Martinuzzi, Italian National Research Council.

April 12. Junior Group Meeting, Room 502[1] at 7:30 p.m.

April 13. Joint Meeting ASME-ASTM, Room 501[1] at 7:30 p.m. Subjects: The Modification of Clouds in the Free Atmosphere, and The Margin of Error in Weather Forecasts, by Vincent J. Schaefer, Research Laboratory, General Electric Company, and Peter E. Kraght, supervisor meteorology, American Airlines, La Guardia Field, New York, N. Y.

April 14. Materials Handling Forum, Room 501A[1] at 7:30 p.m. Subject: Materials Handling in the Budd Plant, by James McMordie, methods and equipment department, Edward G. Budd Company, Philadelphia, Pa.

April 20. Spring Round-Up, at the Latin Quarter at 6:30 p.m.

April 27. Photographic Meeting, Room 502[1] at 7:30 p.m. Subject: One-Millionth-Second X-Ray Photography, by C. M. Slack, Westinghouse Lamp Research Laboratories, Bloomfield, N. J.

*New Haven:* April 14. United Illuminating Company Auditorium, New Haven, Conn. Subject: Politics and Current Labor Trends, by Robert T. Collins, New Departure Division, General Motors Corporation.

*New London:* April 15. Fort Trumbull Branch, University of Connecticut, New London, Conn. Dinner 6:30 p.m.; meeting 8 p.m. Subject: New Forms of Aircraft Propulsion, by A. H. Redding, engineer, Westinghouse Electric Corporation.

*San Francisco:* April 22. Engineer's Club of San Francisco. Subject: Trends in Forced-Circulation Steam Generation, by William J. Besler, chairman of the board, Besler Corporation, Emeryville, Calif.

*Youngstown:* April 13. Westinghouse Club, Sharon, Pa. at 8 p.m. Subject: Electronic Heat, by Hal Toner, electronic sales engineer, Westinghouse Electric Corporation, Pittsburgh, Pa.

[1] Engineering Societies Building, New York, N. Y.



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## MEN AVAILABLE[1]

MECHANICAL ENGINEER, 38, BME, married, 20 years' diversified experience in planning, design, construction, maintenance, and engineering supervision in chemical or processing industries. Registered in New Jersey and Pennsylvania. Me-279.

MECHANICAL ENGINEER, graduate, 22, single. One year's experience as junior industrial engineer for large wire and steel company. Desires permanent position in training program leading to foreign service. Will consider any suitable position. Available March. Location during training, immaterial. Me-280.

MECHANICAL AND MARINE ENGINEER, 25 years' experience. Good organizer. Capable of directing all mechanical operations, precision manufacturing, planning, cost and quality control, and labor relations. Prefer Tampa or Central Florida. Me-281.

MECHANICAL ENGINEER desires position to design and develop product; 6 years products designing, 4 years production supervision, oil-heating equipment. Location preferred, New Jersey. Me-282.

ADMINISTRATIVE ENGINEERS, 36, mechanical, 8 years responsible for equipment design, and for shop, mill, and foundry operation; 5 years consultant and adviser to top management on operating programs, organization, plant planning, operating cost control, job, and salary administration. Progressive administration, able co-ordinator. Me-283.

WORKS MANAGER, 25 years' experience factory management, high-production precision-machine shops, and foundry. Excellent production and labor-relations record. Graduate mechanical engineer, Cornell. Me-284.

MECHANICAL ENGINEER, Cornell graduate, ME, 1938. Broad experience on small devices, including development, specification writing, testing, inspection, and design. Preferably New York, but free to travel. Me-285.

MECHANICAL ENGINEER with experience in inventions, ballistics, tool and process planning, aircraft-production engineering, instructing in engineering drawing and mechanics of materials laboratory, and lecturing in dynamics and statics. Interested in structural design. Desires summer employment. Canadian. Single, locate anywhere. Me-286.

MECHANICAL ENGINEER, graduate and registered with 16 years' experience as chief and plant engineer in process industries, including development, design, and administration. Age 39. Desires permanent position as executive assistant or plant engineer. Me-287.

GRADUATE MECHANICAL ENGINEER, 33, master's degree, desires responsible position in development, design, or stress analysis. Teaching experience in large eastern university. Industrial experience in research, design, stress, and vibration analysis. Me-288.

[1] All men listed hold some form of ASME membership.

## POSITIONS AVAILABLE

CHIEF DRAFTSMAN, mechanical engineer and preferably with some shop experience, who knows practical side of design, to be assistant chief engineer in factory making lift trucks, stackers, and a variety of materials-handling equipment. $5000–$6000. Massachusetts. Y-367.

MECHANICAL ENGINEER, designer, must have photographic-equipment experience and knowledge for large established manufacturer of high-priced quality photographic equipment used in homes and by amateurs, such as motion-picture cameras and projectors. Salary commensurate with experience and ability. New York metropolitan area. Y-369.

PLANT ENGINEER, 30–35, mechanical graduate, with at least three years' experience, preferably in paper mill, to design and lay out installation of paper-making and power-plant equipment. $4000–$5000. Upstate New York. Y-370.

DESIGN AND DEVELOPMENT Engineer, mechanical graduate, with minimum of two years' experience and knowledge of gears, gearing, automotive transmissions, or like products, to do design and development (including testing) of transmissions for internal-combustion engines. Salary dependent upon ability and previous experience. Massachusetts. Y-377

POWER ENGINEER, mechanical graduate, approximately 35 years of age, familiar with design and testing of large power boilers and allied equipment for staff position with boiler-equipment manufacturer. $5000. Eastern Pennsylvania. Y-378.

PLANT ENGINEER, mechanical graduate, under 35, with design, construction, and maintenance experience in a food plant. Some power-plant and refrigeration experience desirable. Salary commensurate with training and experience. Pennsylvania. Y-381.

ASSOCIATE MECHANICAL ENGINEER, young, graduate, with practical design experience in the heating and ventilating field preferably, or design of industrial conveyer systems for textile and paper mills, etc. South. Y-385-(a).

ENGINEERS, P-4 rating, graduates with degrees in either electrical or mechanical engineering; or must have unusually complete technical knowledge of audio systems and if possible, considerable experience with 35-mm sound and projection equipment. Duties will include examining buildings for possible conversion to theaters, installing and maintaining sound and projection equipment, supervision of military and civilian personnel, training personnel in the operation of 16-mm and 35-mm projection equipment, inspecting and recommending improvements in buildings to provide for the safe projection of entertainment film, and other details involved in the operation of motion-picture theaters. To start $6127. Headquarters, Japan. Y-390.

ENGINEERS, young, graduates with chemical- or mechanical-engineering or business-education degrees. Will be given a six-week plant course to generally familiarize them with plant operations for company manufacturing waxed papers, tissue, and gift wrapping papers. $2340–$2860. Vermont. Y-394.

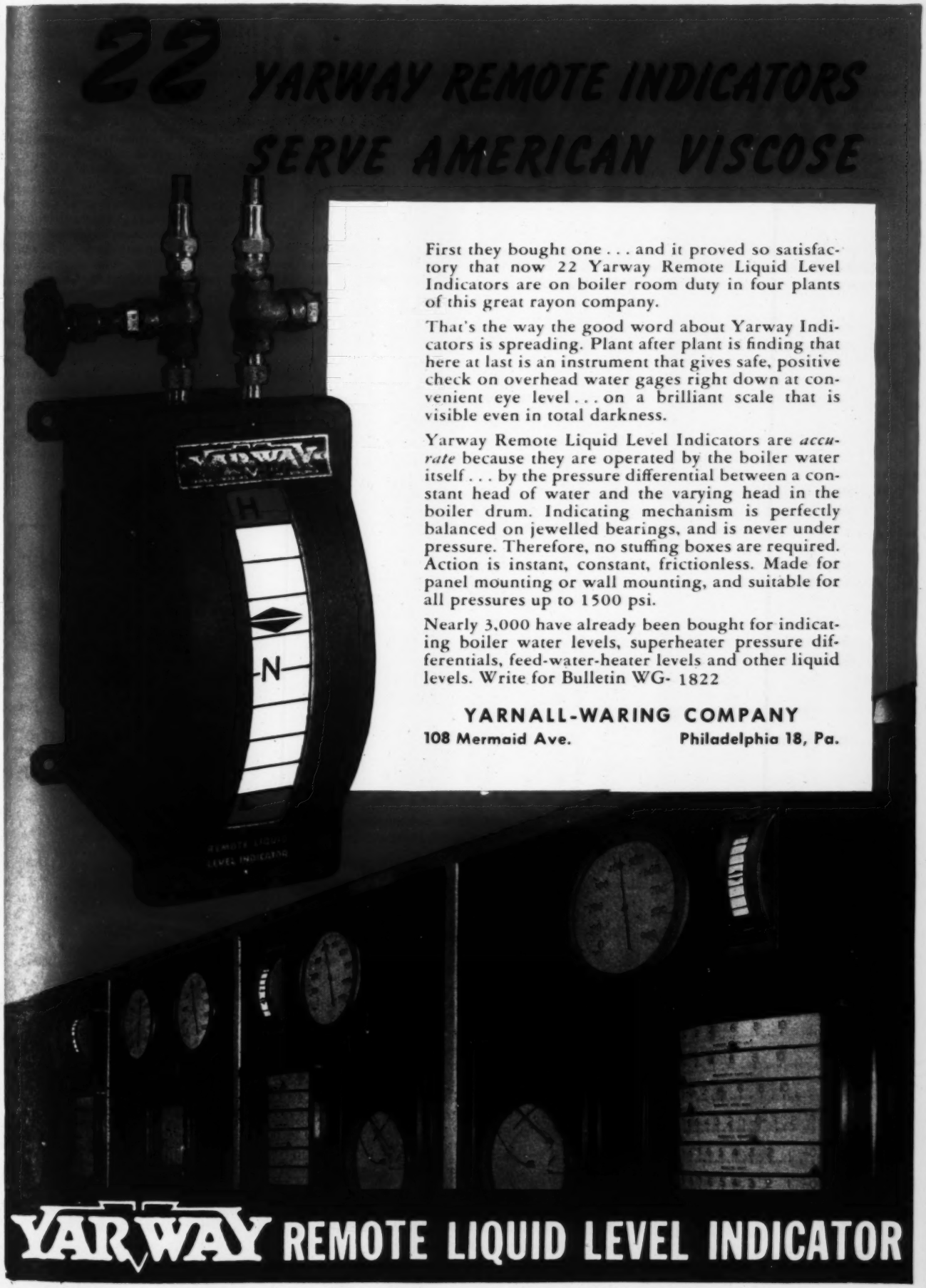
MECHANICAL ENGINEER, under 40, graduate, with at least five years' experience in general plant engineering; rubber-mill experience not necessary, for manufacturer of hard-rubber products. Duties will include design and superintendence of installation of new engineering projects occurring in three plants. Will have full charge of projects assigned, which will include design, selection of equipment, and installation of power plants; power-distribution systems-; steam-, water-, air-, and drainage-piping systems; process equipment, etc. Up to $4500. Some traveling. New York, N. Y. Y-398.

SALES ENGINEER, 23–28, mechanical graduate with experience to sell valves, gas equipment, cooling units, towers, etc. $3000 plus bonus. New York metropolitan area. Y-410.

POWER ENGINEER, 38–45, mechanical graduate, to take charge of boiler plant, turbines, engines, pumps, etc., in manufactured-gas plant. $5000–$6000. New York metropolitan area. Y-411.

GENERAL ENGINEER with degree in one of the branches of engineering study which has included courses in electrical, mechanical, and chemical engineering, with minimum of three years of progressively responsible engineering experience dealing with the procurement of technical equipment of a broad variety. This experience should have demonstrated ability to investigate sources, to select vendors, and to negotiate for procurement of highly technical

(*ASME News continued on page 392*)


22 YARWAY REMOTE INDICATORS SERVE AMERICAN VISCOSE
First they bought one . . . and it proved so satisfactory that now 22 Yarway Remote Liquid Level Indicators are on boiler room duty in four plants of this great rayon company.
That's the way the good word about Yarway Indicators is spreading. Plant after plant is finding that here at last is an instrument that gives safe, positive check on overhead water gages right down at convenient eye level . . . on a brilliant scale that is visible even in total darkness.
Yarway Remote Liquid Level Indicators are *accurate* because they are operated by the boiler water itself . . . by the pressure differential between a constant head of water and the varying head in the boiler drum. Indicating mechanism is perfectly balanced on jewelled bearings, and is never under pressure. Therefore, no stuffing boxes are required. Action is instant, constant, frictionless. Made for panel mounting or wall mounting, and suitable for all pressures up to 1500 psi.
Nearly 3,000 have already been bought for indicating boiler water levels, superheater pressure differentials, feed-water-heater levels and other liquid levels. Write for Bulletin WG- 1822
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specialized materials. Must be able to render technical assistance to contractors regarding processes and equipment. Should have qualifications for liaison work in addition to technical knowledge. $5000. New York, N. Y. Y-415.

SALES ASSISTANT, mechanical or chemical graduate, 25–35, with heat-transfer experience, to analyze inquiries, check specifications, prepare quotations, and attend to correspondence and general office routine. $4000. New York, N. Y. Y-422.

SALES ENGINEER, recent mechanical graduate, to sell compressors, ventilating equipment, controls, etc. $2600. New York, N. Y. Y-432.

MECHANICAL ENGINEER, 35–45, graduate, with design and construction experience, and if possible, some operating experience on natural-gas pipe-line compressor stations, utilizing units of 1000 hp or more. Should be experienced in design of heat-exchange equipment, piping layouts, and should be an administrator capable of handling a small crew of design engineers and general administration of drafting room. $7200–9600. Location, Missouri. Y-435(a).

DIRECTOR, 35–45, mechanical graduate, for school of shop practice for large correspondence school. Must be well versed in general machine-shop and toolroom practices and must have some knowledge of patternmaking and metal founding. Faculty for technical writing essential. $3500–$4000. East. Y-438.

TEST ENGINEER, graduate mechanical or the equivalent, with heavy training in thermodynamics. Should have two to four years' experience in aircraft power-plant test engineering, devising test programs, supervising test runs, and report writing. Experience must include some gas-turbine testing. Salary open. Long Island, N. Y. Y-440.

DESIGNER, mechanical- or chemical-engineering graduate, with eight to ten years' practical experience in chemical-plant equipment design. Up to $5200 depending on experience. Northern New Jersey. Y-442.

MECHANICAL ENGINEERS, not over 40, technical graduates, minimum of five years' experience in piping and heating design and layout. To design and prepare specifications for mechanical equipment in industrial buildings. Basic plant planning. $4200–$4800. New York, N. Y. Y-443(b).

DESIGNING ENGINEERS, mechanical, with broad experience in designing well-drilling machinery, either rotary- or cable-tool types. Positions permanent. Write giving qualifications, experience, and salary expected. Salary open. Ohio. Y-449.

MECHANICAL ENGINEER, young, to work as editorial assistant on a magazine covering generation and application of mechanical and electrical power, such as steam heating, air conditioning, compressed air, pumps, etc. Excellent opportunity for advancement. Salary open. New York, N. Y. Y-459.

MECHANICAL ENGINEER, 35–45, with several years' experience in public-utility work, particularly on high temperature, high pressure, and in addition some turbine work. Up to $7500. Ohio. Y-486(a).

MECHANICAL ENGINEER, graduate, with at least five years' construction experience, to do field engineering covering heating, ventilating, and air conditioning, plumbing, etc. Must be good at taking off plans, estimating, following up job construction, and changes. $5000–$6000. New York, N. Y. Y-506.

MAINTENANCE SUPERINTENDENT, 30–35, mechanical degree, with steel and nonferrous fabricating shop experience, to take charge of maintenance of tools, dies, punch presses, brakes, rolls, etc. $4200–$4800. Pennsylvania. Y-520.

ENGINEERS, (*a*) general manager, mechanical graduate, with executive manufacturing experience, to take full charge of plant manufacturing sheet-metal products. $8000; (*b*) superintendent, mechanical graduate with production, tooling, die, and shop-maintenance experience to supervise shop operations. Salary $6000. Location Long Island, N. Y. Y-530.

ENGINEERS, experienced, mechanical, electrical, or civil degrees, under 35, for major oil company in their operating, terminal, and engineering departments. Duties will consist of construction of new tanks, layout of industrial plants, service stations, etc. $5000–$6000 plus field allowances, retirement plan, and advancement opportunities. Orient. Y-546.

ASSISTANT OR ASSOCIATE PROFESSOR, for engineering college in Iowa. Assistant professor should have either excellent experience, background, or advanced degree in industrial engineering, mechanical engineering, or business administration. Associate professor should have advanced degree master of science or professional degree as a positive requirement. He should also have teaching experience. Salary on a 9-month basis with additional compensation for summer teaching. Assistant professor $3600–$4200; associate professor, $4000–$4800. R-4809C.

INSTRUCTORS, several in engineering drawing in department of engineering mechanics which includes statics, dynamics, mechanics of materials, kinematics, machine design, and materials of construction. Particularly interested in someone with experience in detail machine design. $2400 or more for academic year. In this connection it will be permissible for an instructor with a full teaching load to carry 2 to 4-hours' credit in graduate study toward a master's degree. Position starts September, 1948. R4818C.

# Candidates for Membership and Transfer in the ASME

THE application of each of the candidates listed below is to be voted on after April 25, 1948, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the secretary of The American Society of Mechanical Engineers immediately.

KEY TO ABBREVIATIONS

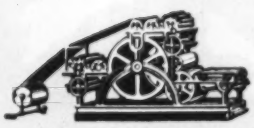
R = Re-election; Rt = Reinstatement; Rt & T = Reinstatement and Transfer to Member.

NEW APPLICATIONS

*For Member, Associate, or Junior*

ABRAMS, LAWRENCE B., JR., Pittsburgh, Pa. (Rt & T)
ALEXANDER, C. S., Cape Town, S. Africa
ALTMAN, NORMAN S., Washington, D. C.
ANDERSON, HALLAM H., Houston, Texas (Rt)
ANDERSON, R. L., West Lafayette, Ind.
ARKIN, DORY S., Raleigh, N. C. (Rt & T)
AUGHTRY, P. C., JR., Savannah, Ga.
AUSTIN, W. C., Atlanta, Ga. (Rt)
BALFOUR, HENRY, New York, N. Y.
BALTHROP, EDWARD S., Staunton, Va.
BANCK, ROBERT A., Detroit, Mich.
BENNETT, JAMES W., Princeton, N. J. (Rt & T)
BENSEN, IGOR B., Schenectady, N. Y.
BLADHOLM, E. F., Los Angeles, Calif.
BLAKESLEE, CLINTON ALFRED, Waterbury, Conn.
BOSTWICK, T. W., Jacksonville, Fla.
BOYLAN, JOSEPH S., Columbus, Ohio
BRAUM, DANIEL MATTHEW, Washington, D. C.
BROWN, ROBERT G., Milford, Conn.
BUTLER, THOMAS M., Detroit, Mich. (Rt & T)
BYE, ROBERT F., Syracuse, N. Y.
CASH, ROY L., Greenville, S. C.
CHENZOFF, PAUL, Philadelphia, Pa.
CHIVENS, CLYDE C., Pasadena, Calif.
CHWOROWSKY, FREDERICK ALEXANDER, Los Angeles, Calif.
CLAPHAM, BRITT E., Omaha, Neb.
CLEMENTS, WILLIAM A., Washington, D. C.
CONNER, ALEX, JR., Dearborn, Mich.
COOGAN, JAMES M., Malvern, Ark.
CORE, CLARK D., Seguin, Texas
COUCH, JAMES G., Charleston, West Va.
CURRIE, THOMAS, Southport, Conn.
DEBRUNNER, D. D., Kansas City, Mo.
DEWALD, HARRY M., Kensington, Md.
DIETLER, HANS, JR., Grand Rapids, Mich.
DINSMORE, MARION GEORGE, JR., Baltimore, Md.
DOVMAN, BARNET, New York, N. Y. (Rt & T)
DUNN, JAMES R., Schenectady, N. Y.
EASTMAN, CHARLES A., South Norwalk, Conn. (Rt & T)
EMMERICH, CLAUDE L., Cincinnati, Ohio
FENN, ALFRED C., New York, N. Y.
FOGG, EDWARD AUGUSTUS, Fairlawn, N. J.
FREEMAN, HOWARD E., Louisville, Ky.
FREEMAN, W. F. Tulsa, Okla.,
FULLER, FORNEY, JR., Charlotte, N. C.
GANEY, JOHN D., Tallmadge, Ohio
GANO, JOSEPH J., Worcester, Mass.
GEORGE, L. B., Montreal, Que., Can.
GERTZ, ALAN, Albany, N. Y.
GRAF, WILLIAM, JR., Wheaton, Ill.
GRIMM, CARL W., Elmhurst, Ill.
GUSSAROFF, HAROLD, Brooklyn, N. Y.
GUY, ROBERT R., Associated, Calif.
HANZALEK, WILLIAM V. JR., New York, N. Y.

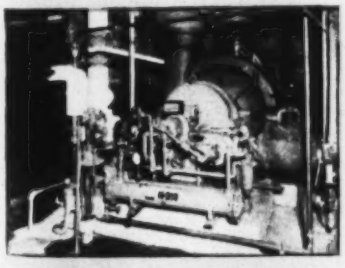
(*ASME News continued on page 394*)



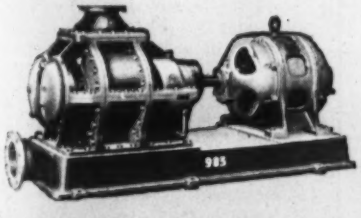
In 1865, William Bullock built the first press which printed from a continuous paper web or roll. Eleven years earlier, in 1854, the first Roots Blower was built. We're not good because we're old, but old because we're good.

# R-C dual-ability

## HELPS DELIVER NEWS OF THE WORLD



R-C Centrifugal Unit (capacity 12,000 CFM), for vacuum service on central system of a large paper mill.



R-C Cycloidal Vacuum Pump (capacity 1,000 CFM), for use with paper mill flat boxes. Compound units of a similar type are used on suction and press rolls.

Papermaking and printing processes require extensive use of equipment to move air. For dependability and economy, blowers and vacuum pumps must be carefully selected and matched to the specific jobs to be done.

That's where *R-C dual-ability* counts most. Because we build both Centrifugal and Rotary Positive units, we can supply whichever type best meets the needs, in capacity, pressure and other characteristics. This *dual choice* is an exclusive Roots-Connersville advantage, one which frequently results in saving time, trouble and money.

If your business calls for the moving, mixing or measuring of air, gas or viscous liquids, consult Roots-Connersville. Almost a century of blower-building experience, plus alert, forward-looking engineering, assure you of sound, practical, economical answers to your equipment problems.

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